US Army Corps of Engineers

Wilmington District

DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT

MANTEO, OLD HOUSE CHANNEL, NC SECTION 204 PROJECT

Image source: http://www.ncfisheries.net/shellfish/recycle1.htm

Beneficial Use of Dredged Material

Section 204 of the Water Resources Development Act of 1992, as amended

February 2014

FINDING OF NO SIGNIFICANT IMPACT

Detailed Project Report and Environmental Assessment

Manteo, Old House Channel, NC,

Section 204 Project

The EA documents the environmental considerations, alternatives considered, and the FONSI documents the decision that no significant impacts to the human environment would occur if the proposal is implemented. The EA and FONSI have been prepared pursuant to NEPA in accordance with the Council on Environmental Quality (CEQ) regulations as contained in 40 CFR Parts 1500 to 1508, which directs federal agencies on how to implement the provisions of NEPA and the US Army Corps of Engineers Department of the Army procedures for implementing NEPA (33 CFR Part 230).

Description of the Proposed Action and No Action Alternative:

The Detailed Project Report and Environmental Assessment (DPR/EA), dated February 2014, describes the proposed action as the Recommended Plan that best meets the planning objectives of oyster habitat restoration and beneficial uses of dredged material within the study area. The proposed action (Recommended Plan) (oyster reef construction) involves use of dredged material from maintenance dredging of Old House Channel to restore habitat by building submerged sand islands to be topped with cultch for oyster reef restoration. Containment of sand for the submerged islands would be accomplished using stone. A complex of three stone containment structures, each enclosing a 5.07-acre reef would be constructed. This plan reasonably maximizes ecosystem restoration benefits and is acceptable to the USACE and local sponsor. The alternative action would be the No Action Alternative: wherein no oyster restoration efforts in the project area would be implemented under this authority.

Public and Agency Coordination:

On April 23, 2013, the DPR/EA, dated March 2013 was mailed to federal and state agencies, local communities, and the interested public for a 30-day review and comment period. Comments received during the review period were reviewed and considered in making the decision to sign the FONSI. Reviewer comments and Corps responses are attached to this FONSI at attachment 1.

a. Summary of Environmental Resources and Impacts:

Section 7.0 of the DPR/EA provides information on the affected environment present in the Manteo, Old House Channel area. The probable consequences (impacts and effects) of the No Action Alternative and the proposed action on the environmental resources in the study area were evaluated. In the long-term, implementation of the Proposed Action will result in positive effects for the Pamlico Sound project area natural resources. No adverse long-term effects would be expected. For the No Action Alternative no project impacts would occur; however, the overall long-term restoration and dredged material placement benefits of the proposed action would be forgone.

b. Facts and Conclusions Leading to the Finding of No Significant Impact (FONSI):

Based on the results of the impact analyses, it has been determined that no significant impacts would occur as a result of implementing the Proposed Action. The Proposed Action would not have any unavoidable adverse effects, nor would it result in the irreversible or irretrievable commitment of resources. Proceeding with the Proposed Action would not significantly or adversely impact the affected environment. Additionally, no significant cumulative effects would be expected.

c. Finding of No Significant Impact:

I have reviewed the Detailed Project Report and Environmental Assessment for Manteo, Old House Channel, NC, Section 204 Project dated February 2014, the information provided by interested parties, and the information contained in this Finding of No Significant Impact, and I find that the proposed action will not significantly affect the quality of the human environment. Therefore, preparation of an Environmental Impact Statement pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended, is not required.

Date: 19 Nov 2014

Kevin P. Landers Sr.
Colonel, U.S. Army
District Commander

Attachment 1

Comments Received on
Manteo, Old House Channel, NC Section 204 Project
March 2013

NC Division of Marine Fisheries

Comment 1: Submerged Aquatic Vegetation (SAV) and shellfish, critical habitat for fishes and invertebrates, are present in the project vicinity. The USACE performed a side scan survey to ensure that no fill will be placed on either SAV or shellfish. Due to the depth and clearance requirements of the reef, SAV habitat will be avoided. However within the northern portion of the identified area, there is an existing shellfish resource and areas that are permitted for shellfish enhancement by DMF (cultch planting). The DMF cultch planting areas should be avoided.

Planting Site		Latitude	Longitude
13-???		35 45.026	75 38.597
		35 44.984	75 38.597
		35 44.984	75 38.542
		35 45.026	75 38.542
12-002		35 45.075	75 38.470
		35 45.075	75 38.415
		35 45.020	75 38.470
		35 45.020	75 38.415
11-003		35 45.090	75 38.650
		35 45.090	75 38.587
		35 45.044	75 38.650
		35 45.044	75 38.587
10-003		35 45.378	75 38.581
		35 45.412	75 38.569
		35 45.409	75 38.601
		35 45.385	75 38.6 60
84-381	Loran C	26972.9	40544
82-308	Loran C	26974.8	40545.3
81-286	Loran C	26972.9	40540.5
81-275	Loran C	26972.9	40544.2

Response 1: These planting areas have been identified by NCDMF as prior cultch

planting areas. Those with Lat/long were plotted and hard bottom is evident on the sidescan survey in the vicinity of these points. All backscatter associated with the cultch areas is located about ½ mile from the proposed reef location. A general map of proposed future cultch placement area was also provided and it appears that the Corps proposed site may encroach into the mapped area proposed by NCDMF, precluding future cultch planting on a small portion of the potential area. The Corps would sidescan the reef area during detailed design and avoid any previously placed shell. It appears that the proximity of the proposed sanctuary would facilitate the sustainability of the cultch planting sited by providing a protected larval supply and be beneficial to this operation, not a detriment.

Comment 2: The NCDMF has concerns that the proposed reefs will impact known fishing areas. The proposed site is a commercial crab pot area, crab dredge area; crab trawl area and oyster dredge area. The area to the north and west of Old House Channel contains a commercially viable oyster resource that has been historically utilized by commercial oystermen. This area was very productive during last year's season. The oyster rocks are also used by recreational fishermen and head boats as they hold recreational finfish species. The USACE should continue to work with NCDMF staff and fishermen in the project area to avoid impacts to known fishing areas. The NCDMF avoids and minimizes these impacts by hosting public meetings when sitting oyster sanctuaries as to avoid any potential conflicts. The USACE should follow similar procedures to ensure no adverse impacts to current fishing areas.

Response 2: In addition to ongoing communication via phone and e-mail, an agency coordination meeting was held in Manteo, NC on January 10, 2012 with representatives from the following agencies and stakeholders: National Marine Fisheries, NC Division of Marine Fisheries, NC Division of Water Resources, NC Shellfish Sanitation, NC Ferry Division, NCDCM, and The Nature Conservancy. We will continue to coordinate with the NCDMF and the fishing community. The site will avoid existing shellfish and should therefore not adversely impact oyster dredging. A protected larval supply provided by the sanctuary should contribute to adjacent oyster areas. It is my understanding that crab pots are not restricted on sanctuary sites. Hard structure provided by this reef would provide improved recreational fishing relative to the existing sand bottom.

Comment 3: The NCDMF supports oyster restoration in the region but this project should be a onetime project. It should not be designed as a continual project unless monitoring concludes that it was a biological and structural success.

Response 3: This section 204 Project is a one-time project. These methods once demonstrated to be successful could provide a future disposal option pending additional coordination and approvals.

Comment 4: The NCDMF has concerns that in this high energy environment it is possible that the "cap" layer of Class B stone may not stay in the designed location

leaving the material uncontained. If the material is not contained it may have adverse impacts on nearby SAV and shellfish through sedimentation. Has this method been successful in other areas or is this the first design? If it has been constructed successfully in the past please provide additional information from that project. The USACE should include surveys yearly and after large storm event if oysters have not formed a more stable cap layer. If the cap layer has not stayed in place the USACE should place more material to prevent sediment movement to avoid impacts to other nearby resources. The NCDMF requests that the USACE provides reports as to the progress and success of the project.

Response 4: In the Chesapeake Bay unconfined dredged material has been capped with cultch providing reef habitat. This design is more conservative providing submerged containment. The proposed dredged materials are sandy and the containment structures provide substantial toe protection. It is not anticipated that capstone or dredged material will leave the site; however, undeveloped buffers will be provided between the proposed site and existing shellfish resources and SAVs are upslope and well away from the reef site.

Comment 5: All previous conditions required for the dredging of Old House Channel should remain. The moratorium requested for the channel dredging should also apply to the placement of the rip rap and piles as well as the filling of the "reef". The purpose of the moratorium is to avoid and minimize impacts from turbidity and sedimentation to fish.

Response 5: Dredging and disposal moratoriums would apply. However, the placement of rock on generally sandy bottoms in the open sound should not generate a significant turbidity risk and the seasonal restriction would increase construction cost and may extend the construction period. Therefore we do not plan to apply a moratorium on the construction of the containment structure.

NC CC & PS – Division of Emergency Management – Floodplain Management Program

Comment 1: Explicitly avoiding vegetation. No SFHA impacts. No comment.

Response 1: Noted.

NC Department of Environmental and Natural Resources – Division of Energy, Mineral, and Land Resources – Land Quality Section

Comment 1: The Land Quality Section has no permitting authority on this project unless more than one acre (in total) of the “reefs” become exposed (above the water surface) during normal tidal action. An erosion and sedimentation control plan will be required if there is at least one acre of exposed “reef”.

Response 1: Noted.

NC Department of Environmental and Natural Resources – Division of Water Quality

Comment 1: The proposed project should account for possible contaminated sediments that will be dredged and relocated to establish oyster reefs. This office encourages the established oyster beds not to be for human consumption until it can be determined that the oysters are not contaminated from the dredged material.

Response 1: Materials are sandy and are not expected to be contaminated. Constructed reefs will be oyster sanctuaries and not used for harvest.

Comment 2: This office is concerned on the potential for structural failure of the "Preferred Alternative" due to the proximity of Oregon Inlet and potential impact on submerged aquatic vegetation within the project area.

Response 2: Containment structures were designed to withstand environmental conditions so that materials would be contained onsite. Site surveys indicated that no SAV were present within the immediate proposed construction area. In addition, known SAV beds in the area are located at elevations above the reef construction area. This protects the SAV from burial from sloughing as sediment would be unlikely to move upslope.

NC Department of Environmental and Natural Resources – Division of Waste Management

Comment 1: The concerns for the UST Section are the staging areas for the dredge material. The proposal has been reviewed and determined that this project should not have any adverse impact upon groundwater.

Response 1: Noted.

Comment 2: The Washington Regional Office recommends removal of any abandoned or out-of-use petroleum USTs or petroleum above ground storage tanks within the project area.

Response 2: If petroleum tanks are encountered at the staging area the UST section will be contacted. However, it is outside of the scope of this project to remove any existing petroleum USTs or above ground tanks.

Comment 3: Any petroleum USTs or ASTs must be installed and maintained in accordance with applicable local, state, and federal regulations.

Response 3: No storage tanks are associated with this project.

Comment 4: Any petroleum spills must be contained and the area of impact must be properly restored.

Response 4: Concur.

Comment 5: Any soils excavated during demolition or construction that show evidence of petroleum contamination, such as stained soil, odors, or free product must be reported immediately to the local Fire Marshall to determine whether explosion or inhalation hazards exist.

Response 5: Concur.

NC Department of Transportation

Comment 1: There are TIP projects that may be located within the aforementioned project limits: B-2500 and R-3116. Please coordinate with NCDOT Division 1 Engineer before beginning any work associated with the subject proposal.

Response 1: NCDOT will be contacted prior to construction of the proposed project.

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List of Acronyms

AAHU	**Average Annual Habitat Unit**
AFP	**Associate Filtered Press**
AIWW	**Atlantic Intracoastal Waterway**
APES	**Albemarle-Pamlico Estuary System**
APNEP	**Albemarle Pamlico National Estuary Program**
CAA	**Clean Air Act**
CAP	**Continuing Authorities Program**
CFR	**Code of Federal Regulations**
CHPP	**Coastal Habitat Protection Plan**
D&I	**Design and Implementation**
DMMP	**Dredged Material Management Plan**
DPR	**Detailed Project Report**
EA	**Environmental Assessment**
EBA	**Environmental Benefits Assessment**
EFH	**Essential Fish Habitat**
EPA	**U.S. Environmental Protection Agency**
ER	**Engineering Regulation**
ERDC	**US Army Corps of Engineers – Engineering Research and Development Center**
FONSI	**Finding of No Significant Impact**
FMC	**Fishery Management Councils**
HAPC	**Habitat Areas of Particular Concern**
HEP	**Habitat Evaluation Procedure**
HSI	**Habitat Suitability Index**
HTRW	**Hazardous, Toxic, and Radioactive Waste**
HU	**Habitat Unit**
IPCC	**Intergovernmental Panel on Climate Change**
IWR-Plan	**Institute for Water Resources, cost-effectiveness/incremental cost analysis software**
LERRD	**Land, Easements, Rights-of-Way, Relocation, and Disposal Areas**
MHW	**Mean High Water**
MHHW	**Mean Higher High Water**
MLW	**Mean Low Water**
MLLW	**Mean Lower Low Water**
MSFCMA	**Magnuson-Stevens Fishery Conservation and Management Act**
MSL	**Mean Sea Level**
NCCF	**North Carolina Coastal Federation**

NCDCM	**North Carolina Division of Coastal Management**
NCDENR	**North Carolina Department of Environment and Natural Resources**
NCDMF	**North Carolina Division of Marine Fisheries**
NCDOT	**North Carolina Department of Transportation**
NCDWQ	**North Carolina Division of Water Quality**
NCORSC	**North Carolina Oyster Restoration Steering Committee**
NED	**National Economic Development**
NEPA	**National Environmental Policy Act**
NEPCC	**National Estuary Program Coastal Report**
NER	**National Ecosystem Restoration**
NEPCCR	**National Estuary Program Coastal Condition Report**
NFS	**Non-Federal Sponsor**
NMFS	**National Marine Fisheries Service**
NOAA	**National Oceanic and Atmospheric Administration**
NPS	**National Park Service**
NRC	**National Research Council**
OMRR&R	**Operation, Maintenance, Repair, Replacement, and Rehabilitation**
ORM	**Organic Rich Mud**
O&M	**Operation and Maintenance**
PAHs	**Polynuclear Aromatic Hydrocarbons**
PPA	**Project Partnership Agreement**
PCBs	**Polychlorinated Biphenyls**
PL	**Public Law**
PNA	**Primary Nursery Area**
POC	**Point of Contact**
PPA	**Project Partnership Agreement**
PPR	**Preliminary Policy Report**
RSM	**Regional Sediment Management**
SA	**NC water classification: "Classified for commercial shellfish harvesting"**
SAV	**Submerged Aquatic Vegetation**
SB	**NC water classification: "Classified for primary recreation"**
SC	**NC water classification: "Classified for aquatic life propagation/protection and secondary recreation"**
SAD	**South Atlantic Division, US Army Corps of Engineers**
SIP	**State Implementation Plan**
SOW	**Scope of Work**

USACE	**US Army Corps of Engineers**
USACE-ERDC	**US Army Corps of Engineers – Engineering Research and Development Center**
USACE P&G	**US Army Corps of Engineers Principles and Guidelines**
US EPA	**U.S. Environmental Protection Agency**
USFWS	**U.S. Fish and Wildlife Service**
WRC/NCWRC	**North Carolina Wildlife Resources Commission**
WRDA	**Water Resources Development Act**

Detailed Project Report and Environmental Assessment

Manteo, Old House Channel, NC Section 204 Project

Executive Summary

This Detailed Project Report and Environmental Assessment (EA) presents the findings regarding the Manteo, Old House Channel, NC Section 204 Project, and documents the plan formulation process and potential environmental effects associated with the implementation of oyster reef restoration alternatives for the proposed site. The geographic scope of this study consists of an approximately 17-square-mile Project Study Area, the center of which is located in northeastern North Carolina, within Pamlico Sound and Dare County, approximately 13 miles south-southeast of Manteo, NC and 4.5 miles southwest of Oregon Inlet. Range 2 of Old House Channel runs through the middle of this area, and is part of the Manteo (Shallowbag Bay) Federal Navigation Project.

The overall goal of the Manteo, Old House Channel, NC Section 204 Project is to improve oyster reef habitat that has been in historical decline in Pamlico Sound, through the beneficial use of dredged material from Old House Channel. In 2008 the State of North Carolina responded to indicators signaling potential further decline of the Pamlico system and its oyster populations by enacting new State coastal stormwater rules to protect and improve water quality. The State also requested the USACE (Corps) to investigate opportunities for oyster restoration in the Pamlico system, indicating a willingness and financial capability to execute a project partnership agreement (PPA) should a detailed project report be approved. This project would contribute to the State's oyster restoration goals in the northern Pamlico Sound in conjunction with the Corp's operational dredging and disposal needs for Old House Channel (Range 2).

This report summarizes baseline existing conditions in the study area, as well as projected future conditions without the project. It also develops and discusses potential solutions as a guide to Federal and non-Federal involvement in the restoration project. This report provides a description and discussion of the likely array of alternative plans, including their benefits, costs, and environmental effects and outputs. This report also identifies, evaluates, and recommends a solution (the Tentatively-Selected Plan) that best meets the planning objectives of oyster habitat restoration and beneficial uses of dredged material within the study area.

The Tentatively-Selected Plan (oyster reef construction) involves use of dredged material from maintenance dredging of Old House Channel to restore habitat by building submerged sand islands to be topped with cultch for oyster reef restoration. Containment of sand for the submerged islands would be accomplished using stone. Based on the cost effectiveness/incremental cost analysis of these options, the best-buy plan would be a complex of four stone containment structures, each enclosing a 5.07-acre reef. However, the best-buy plan has an estimated cost of $8,393,000 and would exceed the federal cost-share limit of the Section 204 authority of $5,000,000. The Tentatively-Selected Plan (TSP) is therefore the most cost-effective alternative with a federal cost within the cost-share limit. The TSP is composed of three stone containment structures, each enclosing a 5.07-acre reef. The Total Project Cost for implementation of the TSP would be $7,217,000 including the fully Federally funded feasibility costs of $453,000. For cost sharing purposes, the total design and implementation phase costs are estimated at $6,763,000, the same amount shown in the draft PPA (annex 12 of this package). Resultant Federal and non-Federal cost shares are $4,396,000 (65%) and $2,367,000 (35%), respectively. The period of analysis used to compute costs is 50 years with a FY12 federal interest rate of 4.0%. This Tentatively-Selected plan would provide restoration benefits of 32.3 average annual habitat units (AAHU) at an average annual cost of $329,429, which results in an average annual cost per AAHU of $10,199. The non-Federal sponsor fully supports the Tentatively-Selected Plan.

1.0 STUDY AUTHORITY AND BACKGROUND

Continuing Authorities Program (CAP) Section 204 of the Water Resources Development Act of 1992 (WRDA 1992) – Beneficial Uses of Dredged Material, as amended by Section 2037 of WRDA 2007.

According to Engineering Regulation (ER) 1105-2-100, paragraph F3.a, "the purpose of CAP is to implement projects of limited size, cost, scope, & complexity". The Section 204 CAP authority authorizes the U.S. Army Corps of Engineers to carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with dredging for construction, operation, or maintenance of an authorized navigation project. The Federal share of the costs for any one project may not exceed $5,000,000. There is an annual appropriation limit of $30,000,000 nationwide.

Cost sharing for Section 204 projects is based on the increase in cost of the ecosystem restoration project compared to the cost of disposal of dredged material without the ecosystem restoration project. Only the increased cost above the cost of the disposal option that would have been implemented without ecosystem restoration (referred to as the Base Plan) is cost shared. The detailed project feasibility study is funded completely by the Federal government. If the proposal is approved for implementation, the non-Federal sponsor responsibilities in accordance with the project partnership agreement (PPA) include: (a) provide all lands, easements, rights of way, and dredged material disposal areas and perform all necessary relocations (LERRD) necessary for the project; (b) participate in the project coordination team; (c) pay any cash contribution during construction necessary so that the total contribution of the non-Federal interest including value of LERRD will be 35 percent of the cost of the project; (c) pay 100 percent of the operation, maintenance, replacement, repair, and rehabilitation (OMRR&R) cost of the beneficial use project. The non-Federal sponsor shall receive credit for the value of in-kind contributions against the requirement for additional cash to bring the non-Federal share of the project to 35 percent in accordance with provisions of SEC.2003 of WRDA 2007. Total project costs are defined as the incremental amount above the costs for the existing dredging plan "base plan" (ER 1105-2-100 Appendix F, pg.F-37).

In July of 2008, the U.S. Army Corps of Engineers received a letter from the North Carolina Department of Natural Resources, Division of Water Resources, requesting the Corps to investigate opportunities for oyster restoration at Old House Channel, Manteo (Shallowbag) Bay, NC under the 204 authority. The letter also indicated a willingness and financial capability to execute a project partnership agreement (PPA) should a detailed project report be approved. In response to this letter, a Preliminary Policy Report (PPR) for this study was submitted to USACE SAD in July of 2008 and approved by SAD in August of

2008. The approved PPR established federal interest in further study of a Section 204 for Manteo, Old House Channel, NC. The results of this study are presented in this Detailed Project Report.

2.0 STUDY GOAL, LOCATION, AND SCOPE

2.1 Study Goal

This study results from both a recognized decline of oyster reef habitat in coastal North Carolina and State efforts for oyster restoration in Pamlico Sound, NC (Street, 2005). The planning study goal is to recommend a cost-effective and environmentally-sound dredged material disposal option that will contribute to the State of North Carolina's oyster restoration goals in the northern Pamlico Sound in conjunction with the Corp's operational dredging and disposal needs for Old House Channel (Range 2).

2.2 Study Area Location

The Study Area is the approximately 17 square-mile area identified in Figure 2.01, which was chosen based on its vicinity to State oyster restoration efforts, and identified dredged material disposal needs from Old House Channel (Range 2). The center of the Study Area is approximately 4.5 miles southwest of Oregon Inlet. Range 2 of Old House Channel runs through the middle of this area. The County impacted is Dare County, NC. The larger surrounding vicinity is Pamlico Sound, NC. A geographic representation of the Study Area within the larger area of the Sound is shown in Figure 2.02.

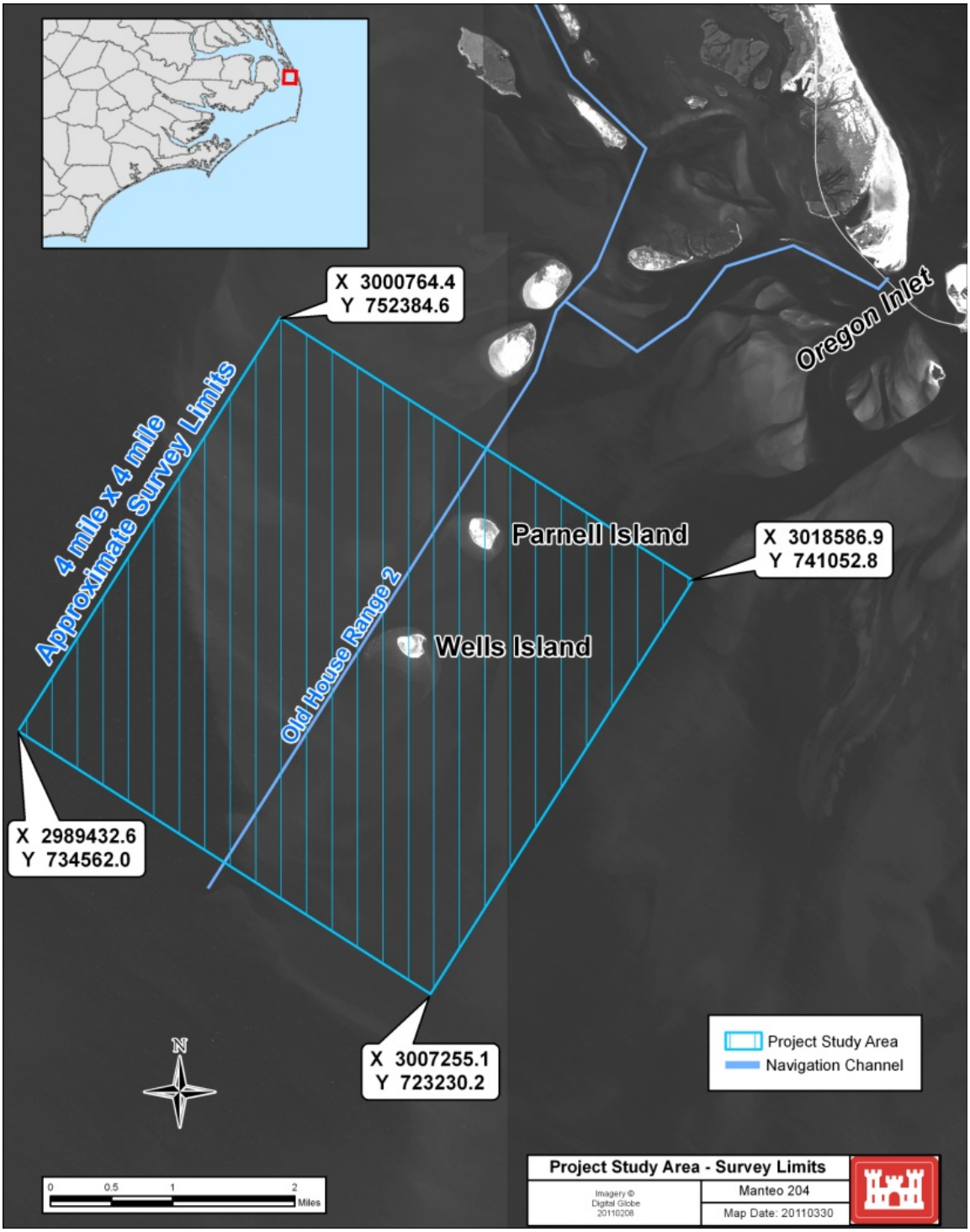

Figure 2.01. *Project Study Area* *Note: Positions are NC Sate Plane feet. NAD 1983.*

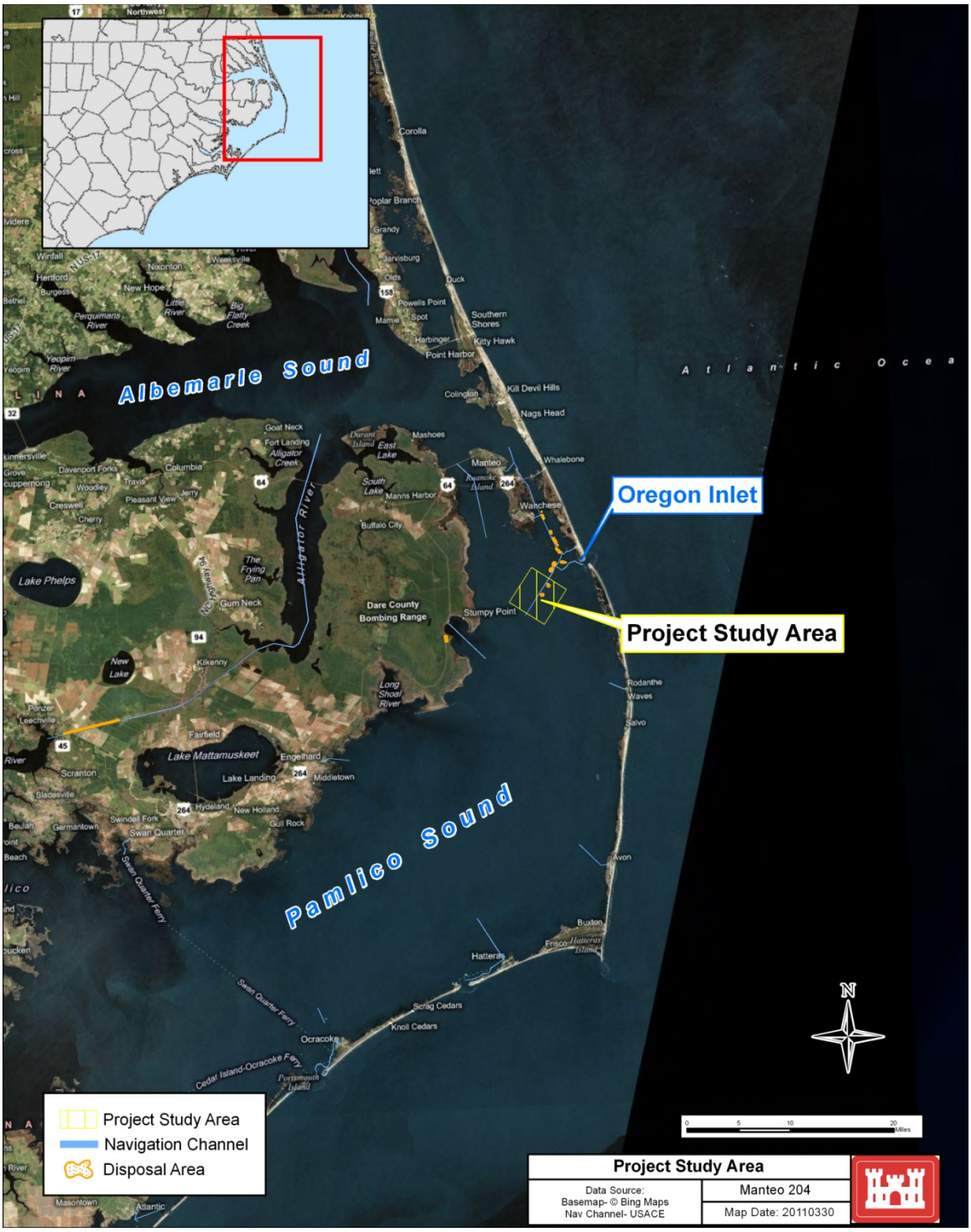

Figure 2.02. *Project Study Area (Yellow Box) in Relation to Surrounding Project Vicinity*

2.3 Study Scope & Process

In accordance with the preliminary policy report (PPR) approved by SAD in August 2008, this study investigates the beneficial use of dredged material from Old House Channel (Range 2) for oyster reef restoration. The report considers an array of alternatives, in addition to a No-Action alternative.

This report documents the study results for the proposed Section 204 beneficial use of dredged material project at Manteo, Old House Channel, NC in the 3rd Congressional District, within Dare County, NC. The study has been conducted in accordance with feasibility study guidelines contained in the Planning Guidance Notebook (ER 1105-2-100) and other applicable USACE regulations and guidance.

The purpose of this Detailed Project Report (DPR) and Environmental Assessment (EA) Study is to:

- Discuss the identified problems, opportunities, and constraints
- Document the project objectives
- Describe existing and potential future conditions
- Identify alternative means to achieve the project objectives
- Analyze the feasibility, costs, benefits, and effects of alternatives
- Recommend an alternative that best meets project objectives in a cost-effective manner

This study will complete the plan formulation process, including the selection of a recommended plan. The level of detail shall be appropriate for the scope and complexity of the CAP study, and sufficient to proceed into detailed design and implementation.

3.0 PRIOR STUDIES, REPORTS, AND EXISTING PROJECTS

3.1 Prior Studies and Reports

For the assessment of existing conditions and the forecasting of future without project conditions, the study team reviewed the following reports as part of this study:

Engineer District, Wilmington, NC, "Supplement No. 1, Manteo (Shallowbag) Bay, North Carolina, Design Memorandum 2, General Design Memorandum Phase II," September 1983.

The report gives a project description and summary for the navigation project in Manteo (Shallowbag) Bay, which includes Old House Channel. Information includes channel width/depth, and dredging cycle.

Manteo Shallowbag Bay Disposal Areas Summary Document. USACE-Wilmington District. 1997.

This summary gives status updates (as of 1997) for the disposal areas of the Manteo Shallowbag Bay navigation project, including Wells & Parnell Islands within the Manteo 204 study area.

Oyster Restoration and Protection Plan for North Carolina: A Blueprint For Action - Second Edition 2008 – 2012

This report, published by the North Carolina Coastal Federation (NCCF) in cooperation with various governmental, non-profit, and private organizations, is a five-year blueprint that outlines a series of goals, objectives, and specific actions that would need to be implemented to protect and restore oyster habitat and shellfish waters. This report also establishes priority areas for oyster restoration in Pamlico Sound. Now that a significant number of the objectives of the first action plan have been realized and new opportunities and challenges have presented themselves, a second edition of the Blueprint has been developed to establish a joint vision among the stakeholders for the next five years. The following goals, objectives and action items represent the second five year cycle of the Blueprint. 1) To restore and protect North Carolina's native oyster populations and habitat in an effort to restore North Carolina estuaries to robust, diverse, & resilient ecosystems; 2) To build broad public awareness & support for the value of oyster restoration, estuarine conservation and sustainable fisheries, and 3) To establish and work with a comprehensive coalition to build and maintain significant, demonstrable and meaningful progress towards oyster restoration in the next five years.

The following summary of the NCDMF Sanctuary Program is quoted from (Eggelston et al. 2011) "The North Carolina Division of Marine Fisheries began the creation of a network of no-take oyster broodstock reserves in 1996 in an effort to enhance the oyster metapopulation in Pamlico Sound. A secondary goal was to create oyster reefs that would serve as EFH, and support recreational and commercial fisheries (NCDMF Stock Status Report 2010). These oyster restoration efforts were accelerated greatly in 2009-2010 with funding via the American Reinvestment and Recovery Act (ARRA), which created 17 ha of oyster reefs in nine months (Pelle Holmlund, NC DMF, personal communication), compared to the previous 49 ha that had been created since 1996. With ARRA funding, new mounds were created during winter of 2009 and early spring 2010 with the addition of 191 and 144 mounds at Clam Shoal and Crab Hole, respectively (NCDMF 2010). As of 2011, a total of 10 brood stock sanctuaries have been established with footprints ranging in size from 1.86 ha to 19.30 ha

and with each reserve containing high-relief (2m) limestone marl mounds (NC DMF). Limestone riprap material used to create oyster broodstock reserves were colonized by oysters via natural settlement, and oyster densities have generally increased in these reserves 5 to 15 fold since 2006 (Puckett & Eggleston, in review).

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside. 2005. *North Carolina Coastal Habitat Protection Plan*. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 656pp.

In accordance with the North Carolina Fisheries Reform Act of 1997, the Coastal Habitat Protection Plan (CHPP) was developed to protect habitats, including wetlands, spawning areas, threatened and endangered species habitat, primary and secondary nursery areas, shellfish beds, submerged aquatic vegetation, and Outstanding Resource Waters. The CHPP was written to "1) Document the ecological role and function of aquatic habitats for coastal fisheries. 2) Provide status and trends information on the quality and quantity of coastal fish habitat. 3) Describe and document threats to coastal fish habitat, including threats from both human activities and natural events. 4) Describe the current rules concerning each habitat. 5) Identify management needs. 6) Develop options for management action using the above information."

U.S. Army Corps of Engineers – Wilmington District, South Atlantic Division. 2009. Draft Interim Feasibility Report and Environmental Impact Statement for the Neuse River Basin.

This ongoing study is also investigating construction of high relief subtidal reefs in the Neuse River, a component of the Albemarle Pamlico National Estuary. This report contains useful information on oyster habitat requirements and potential construction methods, applicable to Old House Channel Section 204 study.

Oyster Settlement and Reef Mapping in Pamlico Sound (July 2009) Ballance, E., Eggleston, D., Plaia, G., and Puckett, B. North Carolina Fishery Resource Grant Project.

This report, the result of a NC Fishery Resource Grant Project, discusses the results of a large-scale field program whose overall goal was to provide data to aid the State of North Carolina in locating oyster broodstock sanctuaries in Pamlico Sound. This study identified live natural reefs in the project area. These reefs were mapped during Corps sidescan surveys and field verified by NCDMF as containing oysters of legal size for harvest. These sites are in open shellfish waters and subject to harvest.

3.2 Existing Projects

***Manteo (Shallowbag) Bay Navigation Project*.** Maintained by the U.S. Army Corps of Engineers, the Manteo (Shallowbag) Bay Project was initially authorized on June 25, 1910, with subsequent modifications to the authorization in 1940,1950 and 1970. The project is located along the Outer Banks portion of Dare County, North Carolina, between Oregon Inlet, Roanoke Island, and Albemarle Sound. The navigation project provides for a channel 14 feet deep and 400 feet wide from the Atlantic Ocean through Oregon Inlet with connecting 12 foot channels, 100 feet wide, to Pamlico Sound, Wanchese, and a 10 feet deep and 100 feet wide, connecting the Manteo-Oregon Inlet Channel with Albemarle Sound. The project is maintained in three general areas: a) Interior Channels (which includes Old House Channel), b) Spit portion of Ocean bar, and c) Outer Ocean Bar. As part of the 1970 authorization, the basin at Wanchese has been further deepened to 14ft. Mitigation for the feature is scheduled for initiation in FY2015, subject to the availability of funds. All remaining 1970 authorized improvements are currently deferred.

State of North Carolina's Oyster Sanctuary Program. The State has ten sanctuaries in the Albemarle-Pamlico Estuary System (APES), with one additional sanctuary in the planning stages (NCDMF website, 2009). The following two are within 0.6 and 2.3 miles of the Manteo 204 project study area, respectively (figure 3.01).

Crab Hole Oyster Sanctuary. Established in 2003, this sanctuary is composed of 16,170 tons of riprap and covers approximately 30.5 acres. Its location is roughly 0.6 miles south-west of the project study area. Partners include the NC Division of Marine Fisheries, Division of Coastal Management, N.C. Department of Transportation, and The Nature Conservancy.

Croatan Sound Oyster Sanctuary. Established in 1996, this sanctuary is composed of 1,800 tons of riprap, 4,000 bushels of oyster shells, 2,640 bushels of surf clam shells, and 4,000 bushels of limestone marl. The sanctuary covers approximately 7.7 acres and is located roughly 2.3 miles north of the project study area. Partners include the NC Division of Marine Fisheries and NOAA's National Marine Fisheries Service.

***Festival Park, Roanoke Island, NC. Aquatic Habitat Restoration and Protection Project*.** This USACE ecosystem restoration project located in the vicinity of the potential project area included subtidal oyster reef construction. Constructed in 2004, this estuarine restoration project restored 5 acres of marsh, seagrass, oysters, and forest. This included the construction of a rock sill for erosion protection and structure comprised of 1,500 cubic yards of marl and 10,000 bushels of oysters along 1,330 feet of eroded shoreline. Partners included the NC Coastal Federation, NC Forest Service, US Fish and Wildlife

Service, NC State University, NC Divisions of Water Resources and Marine Fisheries, and The Nature Conservancy.

Wanchese Marsh Creation and Protection, NC. Section 204 Draft Feasibility Report and Environmental Assessment (1999) USACE-Wilmington District.

This project includes creating and protecting marsh habitat at Wanchese Harbor adjacent to the channel from Oregon Inlet, Dare County, NC. Approximately 8 acres of estuarine creek and marsh area and a containment dike were constructed immediately north of the harbor area. Dredged material from the maintenance dredging of the navigation channel was pumped behind the dike, supplemented by dry trucked sand and graded to create the marsh and estuarine creek habitat .. This successfully completed ecosystem restoration project located in the vicinity of the potential project area included subtidal oyster reef construction and could provide a nearby reference site. Partners included the, NC Divisions of Water Resources and Marine Fisheries

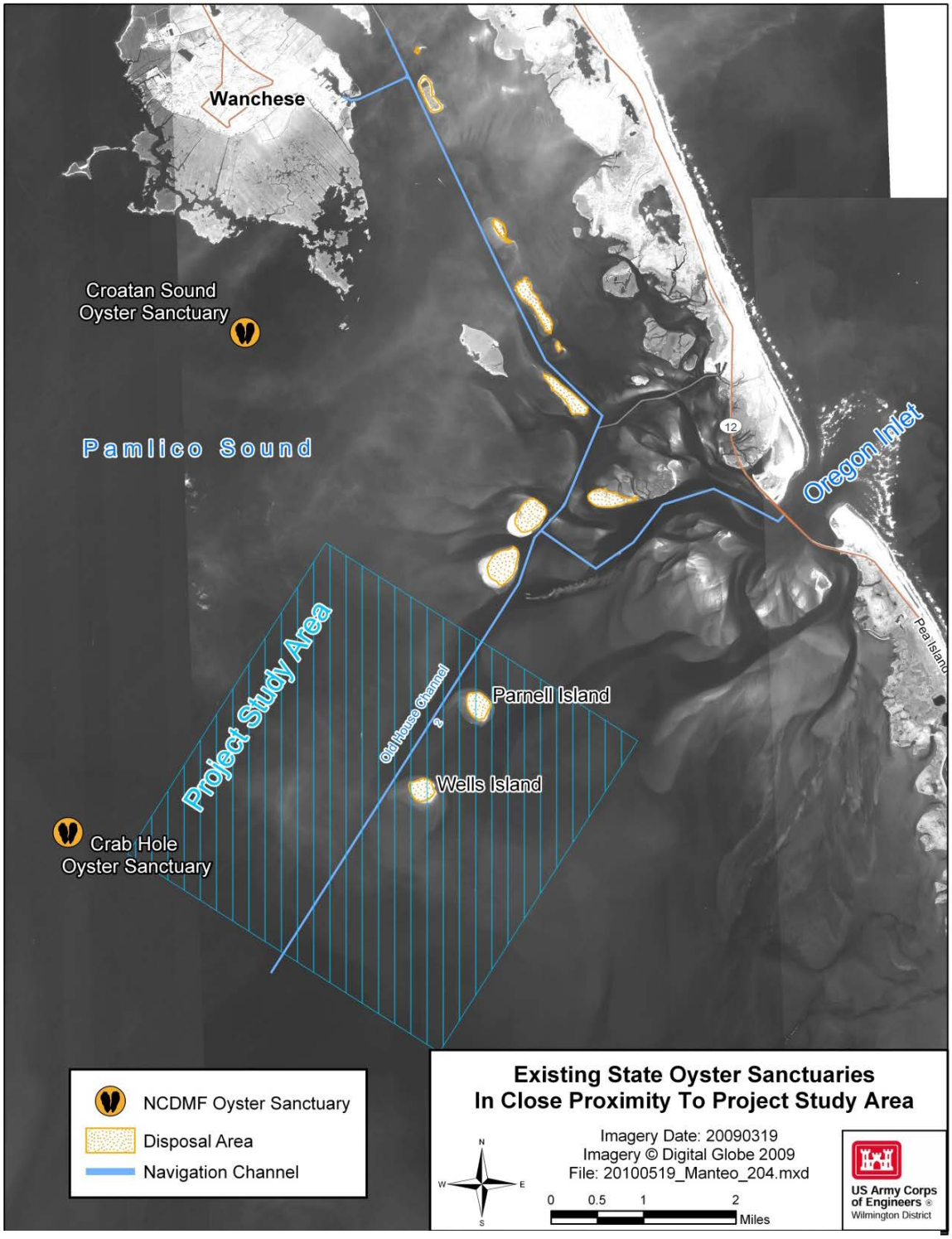

Figure 3.01. *Map Showing Proximity between Nearby NCDMF Oyster Sanctuaries and the Project Study Area*

4.0 EXISTING AND PROJECTED FUTURE – WITHOUT PROJECT CONDITIONS

Each section will identify the existing conditions of the project area including the greater surrounding area that is within Pamlico Sound, as well as a future-without project conditions analysis based on the best available data regarding the projected conditions of the resources without the proposed project. Future-without project conditions analysis assumes that conditions will continue to trend in the direction that is indicated within studies and data available at this time. References to future conditions assume a fifty year projected timeline.

4.1 General Environmental Setting

Pamlico Sound is the second largest sound in the United States and the largest sound on North Carolina's East Coast. It is separated from the Atlantic Ocean by the narrow barrier islands of the Outer Banks. It is part of an interconnected set of estuaries that make up Albemarle Pamlico National Estuary, The Albemarle-Pamlico system represents one of North Carolina's key resource bases for commercial fishing, recreational fishing, and tourism (US EPA National Coastal Conditions Report III, 2008 website):

http://www.epa.gov/owow/oceans/nccr3/downloads.html

The Albemarle Pamlico National Estuary is fed by several major river basins: Pasquotank, Chowan, Roanoke, Tar-Pamlico, Neuse, and White Oak. It also includes seven sounds: Currituck, Albemarle, Roanoke, Croatan, Pamlico, Core and Bogue. Pamlico Sound extends 80 miles from Roanoke Island to Cedar Island and is about 15–30 miles wide reaching depths up to 26 feet. It is connected to the Tar-Pamlico and Neuse-Trent rivers on the west side of the sound, and inlets provide resources from the ocean primarily through Ocracoke, Hatteras and Oregon Inlets (Figure 4.01).

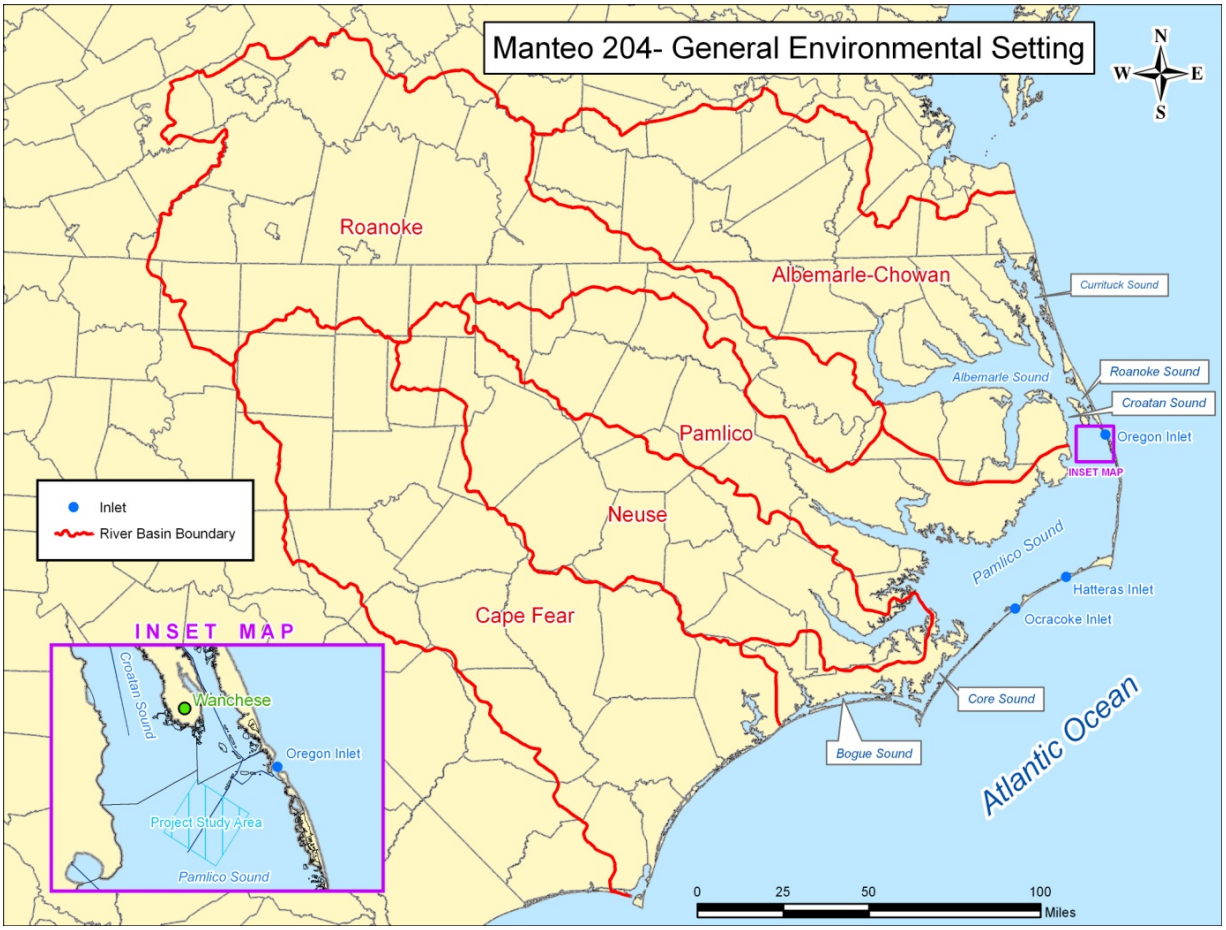

Figure 4.01. *General Environmental Setting*

The project vicinity includes the northern Pamlico Sound, specifically sub-basins 03-01-56, 03-01-51, and 03-01-55. The Study Area is the 17 square-mile area located within the project vicinity (Figure 2.01). As stated in section 2.2, the Study Area was chosen based on proximity to both State oyster restoration efforts, and dredge material disposal needs at Old House Channel (Range 2).

4.1.1 Climate

The Gulf Stream, which runs up the coast from the tropics at four miles per hour, moderates temperatures along the coast. Near Cape Hatteras the Gulf Stream, usually 12 to 15 miles from the coast, begins to move further offshore as it heads towards the British Isles. Coastal North Carolina enjoys moderate climates that are warmer than inland counterparts, with temperatures ranging typically from 50 degrees on average in January to 80 degrees on average in July. This is largely attributed to the consistently warmer waters of the Gulf Stream. However, the cold Labrador Current passes between the Gulf Stream and the North Carolina coast, often offsetting much of the warming effect the Gulf Stream might have on coastal temperatures. The meeting of the two opposing currents provides a high variability that often produces rough weather in the area.

http://www.nc-climate.ncsu.edu/climate/ncclimate.html

Future-without project conditions. Climate along the coastline of the project area is dynamic and highly dependent on seasonal variations. Climate change is expected to have a localized impact on the project area by potentially increasing average water temperatures. An increase in average water temperaturemay have a direct impact on the average seasonal air temperatures of the greater Pamlico area. However, future conditions are not anticipated to exceed the tolerance levels of major resources over the period of analysis and should not have a significant impact on the future conditional analysis of other resources within Pamlico Sound or the immediate project area.

4.1.2 Tides, Currents and Sea Level Rise

The nearest tide gauge to the Manteo, Old House Channel Project Study Area is the Old House Channel gauge (8652648). This site was used as a reference point for this project. Table 4.01 gives pertinent tide range data for Oregon Inlet and Pamlico Sound. It is expected that lunar tides in the project area would be comparable to those exhibited at the Old House Channel gauge.

http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8652648%20Old%20House%20Channel,%20NC&type=Bench%20Mark%20Data%20Sheets

Table 4.01. *Pertinent Tide Data*

Tide Level	m.l.l.w (ft)
Mean Higher High Water (m.h.h.w.)	1.18
Mean High Water (m.h.w.)	1.04
North Americane Vertical Datum (NAVD88)	0.71
Mean Low Water (m.l.w.)	0.13
Mean Lower Low Water (m.l.l.w.)	**0.00**

The lunar tidal range between m.h.h.w. and m.l.l.w. is only 1.18 feet (Table 4.01). The Pamlico Sound wind and long fetch length cause wind to have a greater impact on tide levels than normal lunar tide cycles. Depending on the wind direction, on any given day the tides can be higher or lower than normal. The barrier islands of the Outer Banks also play a part in attenuating the tidal pull within Pamlico Sound. Currents tend to be stronger with closer proximity to Oregon Inlet (Appendix I). Although the project area is several miles from the inlet with typically lower velocity current, the area is dynamic with impacts from frequent storms. Seven named tropical storms have made direct landfall on the

area in the last ten years, in addition to numerous nor'easters (www.nc-climate.ncsu.edu).

Future-without project conditions. Since the project site is in relatively close proximity to the tide data collection site at Oregon Inlet Marina, sea level changes are estimated based upon this tide station, as presented in Figure 4.02. Based on the monthly mean sea level data from 1977 to 2006, the mean sea level trend is 2.82 millimeters/year, with a 95% confidence interval of +/- 1.76 mm/yr. This is equivalent to a change of about 0.47 feet in 50 years. The data set is a shorter than preferred tidal record, but trend is similar to other North Carolina coast sea level trends with longer tide records (Beaufort, NC – 2.57 mm/yr; Southport, NC – 2.08 mm/yr).

http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8652587

Oregon Inlet Marina, NC

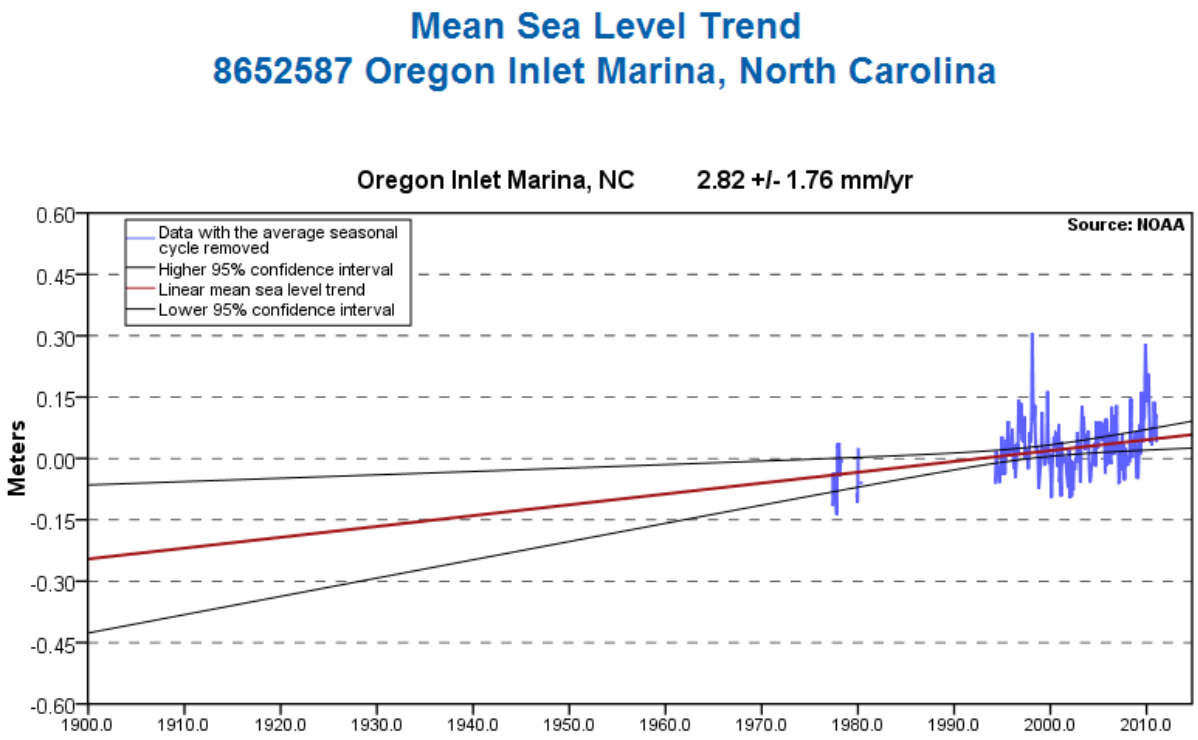

Figure 4.02. *Plot of Tide Levels Oregon Inlet Marina, NC - NOAA Website*

The Intergovernmental Panel on Climate Change (IPCC) projects accelerated global warming which leads to accelerated sea level rise. USACE guidance (EC 1165-2-112) requires consideration of these various accelerated sea level rise scenarios for water resources projects [Note: USACE guidance cited has expired, but alternative guidance has not yet been issued]. The sea level rise global scenarios evaluated include: 1) the historical rate of sea level rise – from

tide data above, 2) projections using the updated National Research Council (NRC) curve 1 – representing global eustatic sea-level rise of 0.5 meters (1.64 ft) in 125 years, and 3) projections based on NRC curve 3 – representing sea level rise of 1.5 meters (4.92 feet) in 125 years.

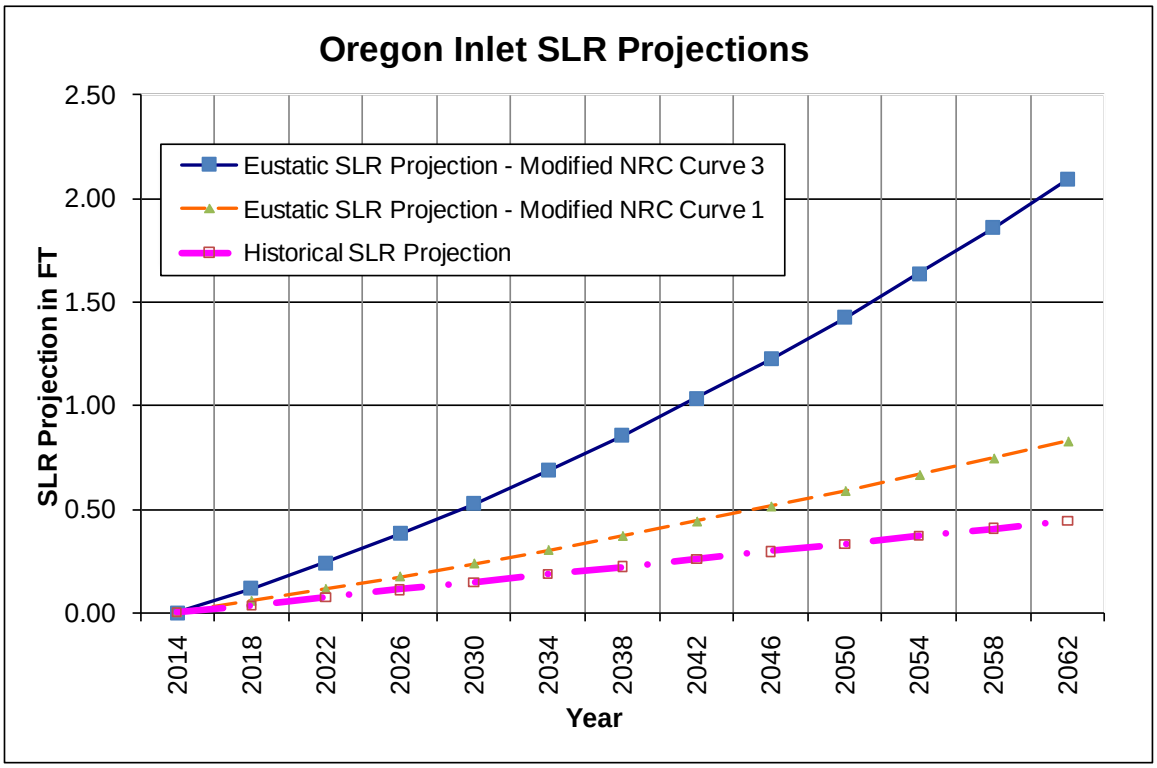

Figure 4.03. *Plot of Sea-Level-Rise 50-Year Projections based upon Historical and Accelerated Rates*

The NRC curves 1 and 3 in Figure 4.03 above have been adjusted to account for local subsidence rates for the Oregon Inlet area. Curves 1 and 3 project an accelerated sea level rise of 0.87 feet and 2.2 feet over a period of 50 years, respectively. Potential sea level rise impacts on the preferred alternative are discussed in Section 7.1.2.

4.1.3 Water Quality

The North Carolina Department of Environment and Natural Resources (NCDENR) classifies the waters from Albemarle Sound to Pamlico Sound as SA. SA waters are tidal salt waters acceptable for shell fishing for market purposes; they are also protected for all class SC and Class SB uses. SC and SB uses include aquatic life propagation and survival, wildlife, as well as recreational activities including fishing and boating and other uses involving human body contact with water.

The water quality of the open water of Pamlico Sound, including the project area located near Oregon Inlet, is considered good SA waters. In the Pasquotank Subbasins surrounding the project area, a small percentage of SA waters are considered impaired for shellfish harvesting. Out of approximately 395,230 acres of shellfish harvesting only 6,471 acres are impaired (1.64%). There are no closed or impaired shell fishing areas in the immediate project vicinity. The nearest closed shell fishing areas are located in Stumpy Point Bay, a small area at the Oregon Inlet Marina, and the southern portion of Wanchese – all of which are over three miles away from the project site.

http://h2o.enr.state.nc.us/basinwide/Pasquotank2007.htm

Water quality monitoring data collected periodically from the nearby sampling station at the Oregon Inlet Fishing Center collected by the North Carolina Shellfish Sanitation and Recreational Water Quality Section between 2006 and 2011, included both salinity and temperature data. Water salinity in the project vicinity averages about 18 ppt. As an indicator species for this study, C. virginica (eastern oyster) has a salinity range in their geographical region from about 10 ppt to 28-30 ppt. (Gunter and Geyer 1955, Gultsoff 1964, Loosanoff 1965, Eleuterius 1977, Wilson et al. 2005). Optimal salinities range from 10 to 20 ppt (Butler 1954, Eleuterius 1977). Temperature in the project vicinity averages about 63 degrees F. Temperature and latitude influences oyster growth, development, reproduction, and feeding activity (Shumway 1996), and temperature is a primary environmental variable affecting the development of larvae (Loosanoff and Davis 1963, Loosanoff 1965). The eastern oyster can tolerate a wide range of temperatures; as low as -1.7ºC (28.9 F) in New England to 36ºC (96.8 F) in Gulf of Mexico (Sellers et al. 1984). Optimal temperatures for growth, reproduction, and survival of adults (Cake 1983) and larvae range from 20ºC (68 F) to 30ºC (86F) (Loosanoff and Davis 1963).

Few direct dischargers of toxic pollution to the sound are known, indicating that nonpoint sources of pollution are probably more significant. Potential nonpoint sources of pollutants include marinas, river basin discharge, solid and hazardous waste sites, and farming runoff. Fecal coli form bacteria continues to be the primary problem parameter. Seventeen marinas exist within the drainage basin, with the largest concentrations occurring at Hatteras, Ocracoke, and in Rose. The closest marinas to the project site are the Oregon Inlet Fishing Center and Wanchese Harbor located over 4 miles and 5 miles away, respectively.

Future-without project conditions. Water quality in the Pamlico Sound will continue to be stressed by burgeoning population, farming, and increased tourism and potentially increasing point and nonpoint sources of pollutants. The National Estuary Program Coastal Condition Report (NEPCCR, 2007) has indicated that there have been some long term patterns that have developed in the past forty years that include both positive and negative indicators. Improvements include increased dissolved oxygen levels and decreased levels

of suspended solids. Negatively, increased levels of *Chlorophyll a* could indicate a trend toward eutrophication. The loss of oysters in the Pamlico Sound may have contributed to this trend (NEPCCR, 2007). Efforts by the state to develop a statewide oyster sanctuary program have the potential to reduce this trend as oysters provide ecosystem services such as water filtration which can reduce eutrophication. The overall conclusion of the Coastal Condition report indicated that the Pamlico system is in good health but that factors exist that may signal the potential for declining health of the system (NEPCCR, 2007). The year following the release of the 2007 NEPCCR, the State of North Carolina implemented new requirements mandating that the state's 20 coastal counties take steps to reduce pollutant-laden stormwater runoff — a major contributor to water quality degradation. In part, the newer rules require buffers and setbacks, address built-upon coverage, and broaden the array of on-site stormwater control and treatment methods for new or redevelopment projects. To view complete regulatory details, go to the NC Division of Water Quality website at:

http://h2o.ehnr.state.nc.us/su/coastal.htm

These rules are in part designed to offset impacts from continued growth in coastal development.

4.1.4 Current Land Use in Project Area

The Project Study Area is located in open-water with no land within several miles, excluding the man-made dredged disposal islands. However, the drainage sub-basins encompassing the greater project vicinity have an overall low population density with seasonal peaks during the summer tourist season. The numbers of individuals that move into the area remain low, limiting the impact that urban development has on the area. Of the basin's total land area, the Albemarle-Pamlico National Estuary program estimates that forests cover 33%, wetlands, swamps, and marshes cover 28%, agriculture comprises 25%, and urban land accounts for under 1 percent.

http://h2o.enr.state.nc.us/nep/tarpamlico_river_basin.htm

Future-without project conditions. Population pressures may stay low due to absence of large cities and the existence of large acreages of protected land surrounding Pamlico Sound. Future conditions are expected to remain relatively stable with minor fluctuations year to year and an overall minor increase in population pressures that should not result in any significant changes to the current condition of Pamlico Sound that would alter the overall health of the system (NEPCCR, 2007, pages 202-211).

4.2 Biotic Communities

4.2.1 Aquatic Habitats

Existing habitats include open water areas comprised primarily of sandy bottom, infrequent scattered oyster reefs, and sparse patches of seagrass. Resources are variable in Pamlico Sound and range from limited resources occurring in frequently dredged channel bottoms to complex and diverse communities occurring in stable grass beds. Table 4.02, based on survey data collected by the USACE between July and September, 2009 (Appendix 1 Survey SOW), indicates submerged aquatic vegetation (SAV), oyster, and island resources within the Study Area.

The State of North Carolina defines primary nursery areas as those areas in the estuarine system where initial post-larval development takes place. These areas are identified and monitored by annual trawl sampling by the North Carolina Division of Marine Fisheries (NCDMF). No Primary Nursery is found in the Study Area. The nearest nursery area is upper Broad Creek located over 7 miles away.

Resource Coverage in Study Area		
Material Type	**Area (sq mi)**	**Coverage (%)**
SAV	2.26	13
High backscatter/shells	0.2	1
Fine Sand	14.79	86
Project Area Totals:	17.25	100

Table 4.02. *Breakdown of Resource Coverage in Project Study Area based on Detailed Side-Scan Survey*

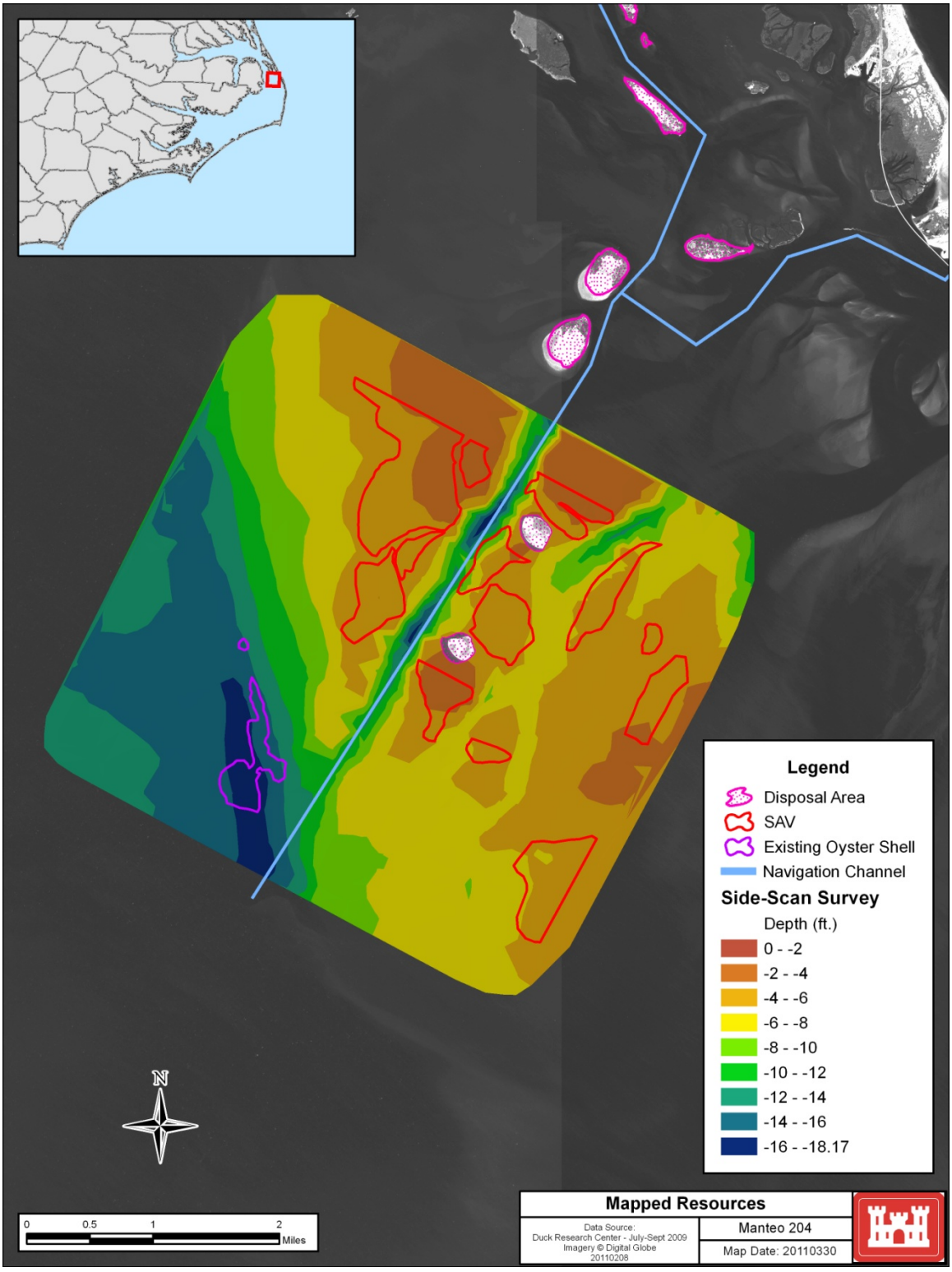

Figure 4.04. *Resources Mapped within Project Study Area along with Existing Disposal Islands (Sonar Survey Mapping, Duck Research Center, Side-Scan Survey – July-Sept. 2009).*

4.2.1.1 Submerged Aquatic Vegetation

SAV stabilizes shorelines by binding underwater sediment with their roots and rhizomes in shallow offshore regions, trapping suspended sediment, and baffling waves and currents. In addition, SAV modifies sediment quantity and quality. In doing this, SAV decreases underwater erosion and improves shoreline structure. Because of this, SAV is a critical part of the structural integrity of North Carolina's near shore environment. SAV also functions as important habitat for many fish and shellfish, including some of the most valuable commercial and recreational species. SAV is home to a diverse group of flora and fauna and is a valuable part of a healthy ecosystem (Street, Deaton, Chappell, & Mooreside, 2005).

Albemarle Pamlico National Estuary Program (APNEP) reports on submerged aquatic vegetation in the Albemarle-Pamlico Estuarine system indicate that the most productive SAV habitats are in the shallow saline waters on the eastern side of Pamlico Sound. Eelgrass, shoal grass, and widgeon grass are common and often dominate these environments. Eighty percent (80%) of the SAV is in southern and eastern Pamlico Sound. Western Pamlico Sound demonstrated a lack of SAV when compared with the eastern portion of the sound (APNEP). It is estimated that there are 200,000 acres of SAV in North Carolina, about as much habitat as there is salt marsh, and SAV comprises about 8.5 percent of the total estuarine bottom in the state (Street et al., 2005).

http://www.cop.noaa.gov/stressors/climatechange/current/slr/habitats.html

A sidescan and multibeam survey was conducted in late summer of 2009 and indicated that 2.26 square-miles of SAV were found within the 17.25 square-mile survey area (i.e., 13% coverage) (see Table 4.02 and Figure 4.04 above).

Future-without project conditions. Based on current trends and conditions it is anticipated that future conditions should continue to improve with natural fluctuations occurring during severe weather events such as droughts and hurricanes (NEPCC, 2007). Stronger regulations have promoted the reduction in nutrients in waters supporting SAV and a decrease in suspended solids and sediments, as well as dissolved solids that have trended downward since the late 1980's (Street et al., 2005). A continued downward trend of sediments and nutrients is expected to continue promoting continued improvements in water clarity, which creates more favorable conditions for many historic SAV beds. The effect of climate change on this habitat includes sea level rise that may increase sedimentation and water temperature, possibly changing species interactions. However, the degree of change that this variable would have on the habitat is unknown at this time.

http://www.cop.noaa.gov/stressors/climatechange/current/slr/habitats.html

4.2.1.2 Shell Bottoms

The North Carolina Coastal Habitat Protection Plan (CHPP) defines shell bottom habitat as estuarine intertidal or sub tidal bottom composed of shell surface concentrations of living or dead oysters, hard clams, or other shell fish with oyster reefs predominating. North Carolina managers consider this habitat critical to fisheries production. Oysters can tolerate extremes in salinity, temperature, turbidity, and low dissolved oxygen, but spawning success requires optimal water quality and good currents for dispersal. Primary producers on shell bottom include algae and organic films of bacteria and fungi which provide food for resident secondary communities of crabs, barnacles, clams, mussels, anemones, polychaetes, amphipods, hydroids, bryozoans, flatworms, mussels and sponges. These species become prey for finfish, shrimps, and blue crabs. Shell bottoms also provide hard, complex substrate to an abundance of plants and animals. Thus this habitat supports many resident and transient fish and invertebrates that are ecologically and economically important (Street et al., 2005). Shell bottom is an important refuge, spawning area, nursery, and foraging area for a diverse community.

http://www.cop.noaa.gov/stressors/climatechange/current/slr/habitats.html

In the wind-driven Pamlico Sound system north of Cape Lookout, oyster reefs consist overwhelmingly of subtidal beds. In the Albemarle-Pamlico estuary, oysters are concentrated in the lower portion of Pamlico Sound tributaries, along the western shore of Pamlico Sound, and to a lesser extent behind the Outer Banks (Street et al., 2005).

The status of the oyster fishery in North Carolina is "concern".

http://www.ncdmf.net/stocks/index.html

Oyster harvests in North Carolina have shown a decrease of 90% from historical landings (Ortega & Sutherland, 1992). Oysters are harvested from October to March with tongs, rakes, or by hand, in intertidal areas and shallow water along the coast. They are also caught by dredges in parts of the Pamlico Sound.

NCDMF website http://www.ncfisheries.net/shellfish/shellfish.htm

Based on USACE survey data collected during the late summer of 2009, a low relief shell bottom habitat covering 0.20 square-miles is located within the 17.25-square-mile surveyed area (i.e., 1% coverage) (Table 4.02).

NCDMF manages ten existing oyster sanctuaries located in estuarine waters from Dare to Carteret counties, with one in the planning stages. The project area is located in relative proximity to two of the oyster sanctuaries (see Figure 3.01). Croatan Sound Sanctuary, established in 1996, covers 7.7 acres and includes

1,800 tons of riprap, 4,000 bushels of oyster shells, 2,640 bushels of surf clam shells, and 4,000 bushels of limestone marl. This site is located about 2.3 miles north of the project area near Roanoke Island. Crab Hole Oyster Sanctuary, established in 2003, covers 30.5 acres. This sanctuary is located about 0.6 miles south-west of the potential project area and is comprised of 16,170 tons of riprap. The attributes of all 10 sanctuaries are shown Appendix I.

Future-without project conditions. Shell bottom has been identified as a habitat of "concern" due to long-term decline primarily due to overharvesting and habitat disturbances (NCDMF website). Other factors contributing to oyster decline include pollution, particularly at river mouths and tidal creeks, and natural disease by parasites such as DERMO. Shell bottom declined throughout the 20th century with landings today at 10% of the historic quantities. However, sampling data shows DERMO (the oyster parasite responsible for disease in the past) has declined in recent years and commercial landings have shown some improvement (Street et al., 2005; NCDMF, 2008); however, habitat (shell bottom) availability is expected to remain a problem, as little generation of shell bottom has occurred within this period of oyster decline. Future conditions are unpredictable, as disease and human impacts may change radically over the next 50 years. However, it is expected that the habitat will remain stable or begin to gradually improve with continued interagency coordination and continued Federal/non-Federal partnerships directed at restoration of shell bottom.

4.2.1.3 Soft Bottom

Soft bottom communities constitute the majority of aquatic habitat in Pamlico Sound. Highly transient communities of macro-invertebrates utilize the area as primary habitat. Seasonal disruptions of the soft bottom from major storms and hurricanes make the area a diverse high energy zone that constantly exhibits changes in its topography.

These habitats are dynamic elements of the coastal landscape that change with shifting patterns of sediment deposition and erosion. Despite a lack of structure, these surface sediments support an abundance of microscopic plants and burrowing animals. North Carolina classifies soft bottom habitats as: un-vegetated shoreline, beaches, intertidal flats and sub tidal bottom in rivers creeks and sounds. The physical and chemical properties of soft bottom habitat affect the benthic organism that dwell there. The shoreline and soft bottom in the northern geologic province consist of four different types of sediment: sand, peat inorganic mud, and organic rich mud (ORM). ORM comprises about 70% of NC estuarine substrate and is concentrated in the central basins of sounds (Street et al., 2005). The southern estuarine system has soft bottom composed of sloped mudflats with extensive tidal channels supporting extensive saltwater marshes due to larger tide range. These large ranges are also found near the 20 inlets through the barrier islands.

One of the most important functions of soft bottom habitat is its enabling of foraging to several trophic levels due to high concentrations of organic matter transported to and produced on soft bottom. This habitat is utilized in this capacity by an abundance of diverse invertebrates, including herbivores, detritivores, and various fish as you move up the food chain. (Street et al., 2005). http://www.cop.noaa.gov/stressors/climatechange/current/slr/habitats.htm

USACE surveys identified 14.79 square-miles of soft bottom in the 17.25-square-mile survey area (i.e. 86% coverage).

Future-without project conditions. Inadequate data exists regarding the future conditions of the soft bottom habitat. As a dynamic habitat type that is highly resistant to any change in conditions it is anticipated that soft bottom will remain status quo with only minor changes occurring regarding the quantity of soft bottom relative to wetlands, SAV, and shell bottom that are much less stable habitats (Street, et al., 2005).

4.2.2 Bird Islands

There are seven man-made sandy islands in the project vicinity that provide a large portion of the primary nesting habitat for colonial shorebird species. Species include brown pelicans, royal and sandwich terns, various species of gulls, and the American Oyster Catcher. These islands were originally built for and are commonly used as disposal through control of effluent islands that receive sandy material from the nearby navigation channel. These islands require an inflow of sediment to remain stable, but are limited in size to prevent predatory hazards that would be associated with a larger island. Two such Islands, Wells and Parnell, are located within the 17 square-mile project study area. They have exceeded their sand disposal capacity and are no longer available for disposal until they have receded back to a manageable size as appropriate for nesting bird islands**.**

Future-without project conditions. Future conditions of the bird islands should remain similar to current conditions with cycles of sand placement on the island followed by the natural erosion of material. Without additional locations for placement of sand materials, navigational maintenance of the nearby channels would require the use of the islands increasingly beyond their approved size which could result in issues such as higher predation of the nesting birds and establishment of plant species that may restrict nesting (USACE-ERDC, 2008). These islands' suitability for nesting is monitored by the North Carolina Wildlife Resources Commission. While there are no current plans for additional bird islands, a dredged material management plan (DMMP) for the Manteo (Shallowbag) Bay Navigation Project is underway and includes considerations for construction of additional bird islands along the interior channels of the navigation project, including Old House Channel.

4.2.3 Wetlands

The estuarine waters and wetlands of Pamlico-Albemarle Sound provide critical nursery areas for more than 75 species of fish and shellfish. Juvenile sea trout, flounder, blue crab, and shrimp, the most commonly fished species, all depend on estuarine wetlands for protection and food. Shrimp production, in particular, has been shown to be directly proportional to the acreage of vegetated wetlands in an estuary. The Clean Water Act and the state's Coastal Area Management Act have decreased the state's wetland loss rate, but coastal states such as North Carolina are still losing wetlands to development more rapidly than is occurring in inland states, particularly in the southeast United States.

http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconections/num2.htm

Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, as defined by the *Code of Federal Regulations* (33 CFR 328.3). Wetlands have three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology.

Coastal wetlands that may occur in the project vicinity include salt marshes, bottomland hardwood swamps, fresh marshes, submerged aquatic vegetation (SAV) and pocosins.

With the exception of SAV as shown on figure 4.04, no vegetated wetlands are located within the 17 square-mile project vicinity. The closest nearby wetlands are tidal marshes found about 4 to 6 miles away.

Future-without project conditions. According to Dahl (1990), by the mid-1980s, North Carolina had lost up to 50 percent of its estimated original wetlands acreage. From 1998 to 2004, in the United States, wetland gains are estimated at 32,000 acres annually (Stedman and Dahl 2008). However, during that same period, coastal watersheds of the United States adjacent to the Atlantic Ocean experienced a net loss of 15,000 acres of estuarine intertidal and freshwater wetlands (Stedman and Dahl 2008). Estuarine emergent wetlands showed the greatest loss declining by about 1 percent on the Atlantic Ocean coast during the 6-year period of analysis. According to Stedman and Dahl (2008), more than half of the U.S. population lives in coastal areas, and development was a major factor in the loss of coastal wetlands along the Atlantic and Gulf of Mexico. Rising sea level, subsidence, and erosion processes also contribute to coastal wetland loss (Stedman and Dahl 2008).

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4.3 Threatened and Endangered Species

An updated list of Endangered and Threatened Species of plants and animals that are expected to occur in the vicinity of Pamlico Sound for the project area are listed inTable 4.03 which was obtained from National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). The actual occurrence of a species depends upon the availability of suitable habitat, the season of year relative to a species temperature tolerance, migratory habits, and other factors.

Table 4.03. *Endangered and Threatened Species Potentially Occurring in Project Vicinity*

Species	Scientific name	Federal Status
Birds:		
Piping plover	*Charadrius melodus*	T
Roseate tern	*Sterna dougallii dougallii*	T
Marine Mammals:		
Blue whale	*Balaenoptera musculus*	E
Finback whale	*Balaenoptera physalus*	E
Humpback whale	*Megaptera novaeangliae*	E
North Atlantic right whale	*Eubalaena glacialis*	E
Sei whale	*Balaenoptera borealis*	E
Sperm whale	*Physeter macrocephalus*	E
West Indian Manatee	*Trichechus manatus*	E
Reptiles:		
Green sea turtle	*Chelonia mydas*	T
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Leatherback sea turtle	*Dermochelys coriacea*	E
Loggerhead sea turtle	*Caretta caretta*	T
American alligator	*Alligator mississippiensis*	T (S/A)
Fishes:		
Shortnose sturgeon	*Acipenser brevirostrum*	E
Atlantic sturgeon	*Acipenser oxyrinchus*	E

T(S/A) = threatened due to similarity of appearance. A taxon that is threatened due to similarity of appearance with another listed species and is listed for its protection. Taxa

listed as T(S/A) are not biologically endangered or threatened and are not subject to Section 7 consultation.

The species expected to occur in the project area are the West Indian manatee (*Trichechus manatus),* shortnose sturgeon (*Acipenser brevirostrum), Atlantic Sturgeon (Acipenser oxyrinchus),* the multiple species of sea turtle that frequent the North Carolina coast as well as, the shore bird species of piping plover (*Charadrius melodus)* and roseate tern (*Sterna dougallii dougallii* that may use the bird islands.

Whale species are not expected to occur within Pamlico Sound as whale species tend to stay off the coast of North Carolina and do not enter the sound. The project vicinity does not include habitat of the dune plant seabeach amaranth (*Amaranthus pumilus)* and, therefore, this species would not be encountered.

Manatee. There is no information available that would allow the prediction of West Indian Manatee's occurrence at any given site at any given time. It can only be assumed based on recorded sightings that the likelihood of it occurring in the area is low.

Future - without project conditions. Based on an unpublished species profile for the West Indian manatee (specifically the Florida manatee) by the U.S. Fish and Wildlife Service, a general trend appeared from 1993 to 2001 showing a population increase of manatees in Florida. As North Carolina does not have a resident population of manatees it is assumed that manatees spotted in North Carolina are transients from the south, most probably Florida. For this reason data gathered in Florida can be utilized to ascertain the future likelihood on manatee sightings. With increasing water temperatures and the gradual increase in population size, it can be expected the likelihood of an encountering a manatee will increase over time within the project area but should not increase to the degree that a resident community of manatees would inhabit Pamlico Sound.

http://ecos.fws.gov/docs/recovery_plan/011030.pdf

Shortnose Sturgeon. The shortnose sturgeon range extends along the Atlantic seaboard from the Saint John River in New Brunswick, Canada to the Saint Johns River, Florida. Historical records indicate that shortnose sturgeon used to be abundant within Pamlico Sound but up until less than a decade ago, were thought to be extirpated from North Carolina. In 1998, NCDMF captured an adult shortnose sturgeon in Western Albemarle Sound providing evidence for the existence of a shortnose sturgeon population (NMFS, 1998). There is no breeding habitat available for the species in the project vicinity; however, adults may be encountered in the project area when the over-wintering population moves into the Roanoke/Chowan River Basin.

Atlantic sturgeon. Ranges of the Atlantic sturgeon are similar to that of the shortnose sturgeon discussed above with the species' historic range including

major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (Murawski and Pacheco, 1977; Smith and Clungston, 1997). Atlantic sturgeon were once abundant in many coastal rivers and estuaries in North Carolina. The largest historic Atlantic sturgeon fisheries occurred in the Cape Fear River and the Roanoke River/Albemarle Sound system where current spawning has been documented in both systems (ASSRT, 2007). Man-made structures, such as dams, have limited the species spawning habitat and ability to reproduce. The Atlantic sturgeon is listed as Endangered. Within the Federal Register dated February 6, 2012 (Volume 77, Number 24), NMFS issued a final determination to list the Carolina and South Atlantic distinct population segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) as endangered under the Endangered Species Act (ESA) of 1973, as amended. This final rule was made effective April 6, 2012. There are currently recovery programs in place for Atlantic sturgeon. As with the shortnose sturgeon, there is no breeding habitat available for the species in the project vicinity but adults may be encountered in the project area. Although it is unlikely species may occur in the project area, it is expected that the sturgeon are mobile enough that they will not be restricted from moving outside of the project vicinity.

Future - Without Project Conditions. Man-made structures that restrict the spawning of shortnose and Atlantic sturgeon will continue to keep populations at a low level. Data is unclear regarding the locations and distributions of either populations within Pamlico Sound so population trends and other tools used to determine the health and status of a population are unavailable at this time. It is anticipated that continued recovery programs and the active removal of many un-natural structures that currently block spawning grounds for the shortnose and Atlantic sturgeon will continue to bolster the native populations and may promote the growth of the native populations, increasing the chances of an encounter.

http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf

Sea Turtles. Sea turtle species commonly associated with the North Carolina coast have been known to traverse through Oregon Inlet and into Pamlico Sound. The loggerhead and green sea turtle are considered to be the only species to nest on the beaches nearest the project area. However, the leatherback, hawksbill, and Kemp's ridley sea turtle have been documented within or on the adjacent beaches of Pamlico Sound. While these species may occur within the project area, it is unlikely that sea turtles will be encountered due to the time of year that construction phase work would be proposed and the mobility of sea turtles to move outside of project range.

Future – Without Project Conditions. Population trends from NOAA and analyses of historic and recent abundance indicate that extensive population declines have occurred over the past 100 years with an overall decline in mature females nesting. In particular from 1998, after seeing an upward trend in nests since 1989, populations of nesting turtles dropped 43%. Mitigation of hazards

that are suspected of contributing to the decline of turtles including predation by foxes, coastal trawling impacts, and more strict dredging requirements should contribute to continuity of the various species. However, limited data makes a determination on the future of the species difficult. It is expected that populations may slow in their decline and, in some cases begin to recover, but will not recover to the point of de-listing during the 50 year period of interest.

http://www.nmfs.noaa.gov/pr/species/turtles/

Birds. Piping plover (Charadrius melodus) and roseate tern (Sterna dougallii dougallii) are fairly common along the North Carolina Coast. Both species are considered shorebirds that nest in low numbers along the area beaches and bird islands. Potential nesting habitat is located outside of the 17 square-mile survey area and species will not be in direct contact with the proposed project.

Future – Without Project Conditions. Populations are expected to stay status quo during the 50 year study period with little change from their current "Threatened or Endangered Status". Mortality of adults during migration and major storm events along with occasional predation will continue to occur. Occasional shifting of nesting locations may occur but populations should remain in the general vicinity.

4.4 Benthic Resources

Benthic resources in the Northern Pamlico Sound are variable, from limited resources occurring in frequently dredged channel bottoms to complex and diverse assemblages occurring in stable grass bed areas. Ecologically and economically important benthic species known from the project area include blue crabs (Callinectes sapidus), shrimps (Penaeus spp.), clams (Mercenaria mercenaria), and oysters (Crassostrea virginica).

The Southeast Coast Benthic Index rated the benthic condition of the Albemarle-Pamlico Estuarine Complex as fair with 65 percent of the area rated in good condition, and sixteen (16%) percent of the area rated poor. None of the poor location are in the project area; the majority are in the Neuse Estuary. Degraded areas were often associated with adverse water and sediment quality (NEPCC, 2007).

Future - Without Project Conditions. Future conditions in the project vicinity are expected to remain stable with an overall quality rating of fair. There is no data indicating a change in this condition.

4.5 Essential Fish Habitat (EFH) and Fisheries

The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) set forth new requirements for the National Marine Fisheries Service (NMFS), regional fishery management councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of federally managed fisheries. The project area may include species that are managed by, or are of particular interest to the Mid and South Atlantic Fishery Management Councils, as well as the Atlantic States Marine Fisheries Commission. The NMFS Southeast Region is the point of contact (POC) for EFH for this project. Table 4.04 lists, by life stages, the 14 fish species which may occur in Pamlico Sound and which are managed under MSFCMA. These fish species and habitats require special consideration to promote their viability and sustainability. The potential impacts of the proposed project on these fish and habitats are discussed in Section 7.5.

Essential Fish Habitat Species, Pamlico Sound Dare County, NC			
EFH Fish Species	**Life Stage Present**	**EFH Fish Species**	**Life Stage Present**
Bluefish	E L J A	Black Sea Bass	L J A
Summer Flounder	L J A	Spiny Dogfish	E L J A
Gag Grouper	J	Brown Shrimp	E L J A
Gray Snapper	J	Pink Shrimp	E L J A
Cobia	E L J A	White Shrimp	E L J A
King Mackerel	J A	Sandbar Shark	J A
Spanish Mackerel	J A	Sheepshead	J A
Life Stages	**E=Eggs; L=Larval; J=Juvenile; A=Adult**		

Table 4.04. *Essential Fish Habitat (EFH) Species Present in Pamlico Sound, Dare County, North Carolina. Source: NMFS, Beaufort, North Carolina, October 1999.*

The Fishery Management Plan Amendments of the South Atlantic Fishery Management Council identify a number of categories of Essential Fish Habitat and Habitat Areas of Particular Concern, which are listed in Table 4.05. While all 26 of these habitat categories occur in waters of the southeastern United States, many are absent from the Pamlico Sound Estuary. Those absent include estuarine scrub/shrub mangroves which require a more tropical environment and several areas that are geographically removed from the project area including: Hoyt Hills located in the Blake Plateau area in water 450-600 meters deep, Cape Fear Sandy Shoals also known as Frying Pan Shoals, Big Rock and Ten-Fathom Ledge located off Cape Lookout, Hatteras Sandy Shoals, New River, and Bogue Sound. In addition, the Pamlico Sound does not include marine (ocean) areas or state-designated areas of importance for managed species (primary nursery areas).

Areas found in the Pamlico Sound include: estuarine water column, aquatic beds, estuarine emergent wetlands, oyster reefs and shellbanks, palustrine forested wetlands, seagrass (submerged aquatic vegetation).

The 17 square-mile project study area includes estuarine water column, aquatic beds, oyster reefs and shellbanks, and seagrass (submerged aquatic vegetation).

Table 4.05. *Categories of Essential Fish Habitat and Habitat Areas of Particular Concern in Southeast States*[1]*.*

ESSENTIAL FISH HABITAT	**GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN**
Estuarine Areas	**Area – Wide**
Aquatic Beds	Council-designated Artificial Reef Special Management Zones
Estuarine Emergent Wetlands	Hermatypic (reef-forming) Coral Habitat & Reefs
Estuarine Scrub / Shrub	Hard Bottoms
Mangroves	
Estuarine Water Column	Hoyt Hills
Intertidal Flats	*Sargassum* Habitat
Oyster Reefs & Shell Banks	State-designated Areas of Importance of Managed Species
Palustrine Emergent & Forested Wetlands	Submerged Aquatic Vegetation (SAV)
Seagrass	
	North Carolina
Marine Areas	
	Big Rock
Artificial / Manmade Reefs	Bogue Sound
Coral & Coral Reefs	Capes Fear, Lookout, & Hatteras (sandy shoals)
Live / Hard Bottoms	New River
Sargassum	The Ten Fathom Ledge
Marine Water Column	The Point

[1]Areas shown are identified in Fishery Management Plan Amendments of the South Atlantic Fishery Management Council and are included in Essential Fish Habitat: New Marine Fish Habitat Mandate for Federal Agencies. February 1999. (Tables 6 and 7).

Overall, based on the fish tissue contaminants index, the Albemarle-Pamlico Estuarine Complex is rated good to fair. Ten percent of the stations sampled exceeded the risk-based EPA Advisory guidance values and were rated poor.

Twenty percent of stations were rated fair and seventy percent were rated good with the only contaminants measured being total PAHs and total PCBs.

Future - Without Project Conditions. Declining stocks of local populations of fish that include; Atlantic croaker, Atlantic sturgeon, eastern oyster, red drum, striped bass, summer flounder, weakfish, and herring are apparent in downward trends of commercial landings despite improvements in fishing methodologies and gear. It is expected that without better management practices that manage overfishing and habitat loss this trend may continue (NEPCC, 2007).

4.6 Sediments

The assessment of the existing condition of sediment in the Project Study Area is based largely on vibracore sampling by the USACE during the feasibility study. These boring samples were then analyzed by Terracon Inc. The results of the laboratory testing of these samples are presented on the grain size analysis sheets, summarized in the boring logs, and provided in Table E-2 in Appendix E. In general, the materials encountered in the northern portion of Old House Channel, Range 2 consist of fine sand (SP) and fine sand with silt (SP-SM) with composite percent silt content at less than 10%. The materials encountered in the southern portion of Old House Channel, Range 2 generally consists of fine sand (SP), fine sand with silt (SP-SM), silty fine sand (SM), and elastic silt with sand (MH). The material encountered in the potential placement areas ranges from fine sand (SP) in some areas, to fine sand with silt (SP-SM), silty fine sand (SM), and elastic silt with sand (MH).

Future - Without Project Conditions. The distribution of bottom sediments is not expected to have any significant change over time. Suspended solids have trended downward over the last 30 years with spikes occurring during major storm events. Conditions at the project area are not expected to vary greatly outside of those storm events. The sediment quality index that evaluates toxicity, contaminants, and carbon determined that the Albemarle-Pamlico Estuarine complex is rated good to fair with two sampling sites near the project rated good. The overall condition rating was distributed as 93% good and seven percent rated poor. These evaluations are not anticipated to drastically change in the foreseeable future (NEPCC, 2007).

4.7 Coastal Processes

The Project Study Area is located near Oregon Inlet in a highly dynamic area subject to external forces including wind, waves, and tides. The predominant winds occur from the northeast and the southwest which is typical of the entire coast of North Carolina. Winds play an important role in the tides. Fluctuation of the water level as a result of wind action is a common and daily occurrence. Water levels are determined primarily by the speed, direction, and duration of surface winds. Astronomical tides play a small role in the water level due to the distance from Oregon Inlet and the buffering provided by the barrier islands. Waves in the Project Study Area are affected more by winds than by the ocean swell entering the sound through Oregon Inlet. The area is dynamic with impacts from frequent storms. Seven named tropical storms have made direct landfall on the area in the last ten years, in addition to nor'easters (www.nc-climate.ncsu.edu).

Future - Without Project Conditions. Existing coastal processes within the project area are not expected to change. The external forces of wind, waves and tides will continue to impact the project area. Water levels will continue to be impacted primarily by wind with minor impacts resulting from astronomical tides (for Sea Level Rise see analysis in Section 4.1.3)

4.8 Air Quality

The Washington Regional Office of the North Carolina Department of Environmental and Natural Resources has air quality jurisdiction for the project area. The ambient air quality for Dare County has been determined to be in compliance with the National Ambient Air Quality Standards, and this county is designated as an attainment area. The State of North Carolina does have a State Implementation Plan ("SIP") approved or promulgated under Section 110 of the CAA. However, for the following reasons, a conformity determination is not required:

a. 40 CFR 93.153 (b), "For federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a nonattainment or maintenance area caused by a federal action would equal or exceed any of the rates in paragraphs (b) (1) or (2) of this section." Dare County has been designated by the State of North Carolina as an attainment area.

b. The direct and indirect emissions from the project would fall below the prescribed minimum levels (58 Fed Reg. 93.153(c)(1)) and, therefore, no conformity determination would be required.

c. The ambient air quality for Dare County has been determined to be in compliance with the National Ambient Air Quality Standards. This project is not anticipated to create any adverse effect on the air quality of this attainment area.

Future - Without Project Conditions. Air quality is not expected to decline in the future. Recent results of air quality testing (ozone and particle pollution) by the NC Division of Air Quality have indicated a decrease in high exceedance days in North Carolina showing that air quality may be improving over time

http://daq.state.nc.us/news/pr/2010/ozone_forecasts_03312010.shtml

Dredging operations that release minimal levels of emissions in the project area will continue on a regular dredge cycle to maintain navigation routes.

4.9 Socio-Economics and Recreation

Recreational and commercial fisherman use the Pamlico Sound extensively for fisheries and shellfish resources, making up a large percentage of North Carolinas' total revenue for fisheries. The Sound is especially known for its blue crab and oyster resources. Commercial fishing practices in the basin include pound nets, long haul seines, shrimp and crab trawls, crab pots, and sink gill nets. Shellfish (including crabs, oysters, and bay scallops) are taken by tonging, raking, bull raking, hand harvesting, and dredging.

Tourism in the counties surrounding Pamlico Sound relies on maintaining a high level of support from fishing tournaments and the influx of boaters that utilize the many marinas within Pamlico Sound. The Project Study Area is popular for fishing due to its vicinity to Oregon Inlet and its containment of a variety of habitats. Sidescan data has indicated SAV, oyster reefs, shoals, and deep water habitats, which attract fish and fisherman to the area (Figure 4.04).

Navigational support to marinas and vessels providing goods and supplies, as well as bolstering the local, recreational, and tourism markets in the surrounding area reinforces the need for navigation channels and the constant maintenance that is required to keep the channels open. Providing alternative methods for placement of material that has been removed from these navigational channels is crucial to maintaining the economic stability of the surrounding area that relies heavily on access to the waterways.

Future - Without Project Conditions. Activities that contribute to the socio-economics of the greater community in the surrounding project area are closely tied to commercial fishing and recreational vessel access and passage. Safe and viable vessel passage is expected to remain a critical component of the area's socio-economic structure. This requires that navigation channels remain open; therefore, channel maintenance requirements are not expected to change significantly in the future.

4.10 Cultural Resources

The study area is located in Pamlico Sound within the Outer Banks of North Carolina, and specifically, the Oregon Inlet vicinity. The inlet was created by a storm in September 1846 that pushed water over Bodie Island (Angley, 1985). Oregon Inlet remained unimproved, save lighthouse constructions and Civil War fortifications, and migrated approximately a mile south, before channel dredging was begun in 1910 to link Manteo (Shallowbag) Bay to the inlet (Angley, 1985). Historical research has identified the loss of ninety vessels in the vicinity of Oregon Inlet (Tidewater Atlantic Research, 1992). Despite the large number of sunken vessels in the vicinity, there are no known recorded archaeological sites within the proposed project area (North Carolina State Historic Preservation Office. Letter to Corps of Engineers 18 June 2009). The Corps of Engineers will consult with North Carolina Office of Archaeology's Underwater Archaeology Branch when specific construction areas are identified.

Future - Without Project Conditions. No known recorded archaeological sites are within the proposed project area (North Carolina State Historic Preservation Office. Letter to Corps of Engineers 18 June 2009). Therefore, there would be no effect or change from existing conditions that would affect cultural resources. However, there is always the possibility that an unknown cultural resource will be identified in the future.

4.11 Hazardous, Toxic, and Radioactive Wastes

The project area under consideration is not located in or near an industrial site or dump. If hazardous and toxic wastes are identified in the area, response plans and remedial actions will be conducted as appropriate.

Future - Without Project Conditions. Waste sites are not expected to be discovered in the future.

4.12 Floodplains

The Pamlico Sound proposed project area is not located within a floodplain. It is submerged.

Future - Without Project Conditions. Future conditions analysis suggests that the project area will not become a floodplain.

4.13 Other Environmental Considerations

The following environmental factors have been considered based on existing and future conditions and due to the unlikely circumstance that they will change or be impacted were excluded from further analysis: *aesthetics, noise, and geology*.

5.0 PLAN FORMULATION AND ALTERNATIVE EVALUATION

This section discusses problems, opportunities, restoration objectives and constraints within the study. Based on these problems, opportunities, objectives and constraints, a series of restoration alternatives have been developed.

5.1 Public Concern

Input was received through coordination with the sponsor, coordination with other agencies, and public distribution of the project scoping letter. A discussion on public involvement is included in Section 9.0 of this report. The public concerns that are related to the establishment of planning objectives and planning constraints are:

1. The State of North Carolina has indicated concern for the historical loss of oyster reef habitat in Pamlico Sound.

2. Both state and Federal resource agencies have expressed a desire to restore a self-sustaining network of oyster reef habitat in Pamlico Sound. The Sponsor, the State of North Carolina, has indicated a desire for beneficial use of the sediments at Old House Channel for oyster reef restoration.

3. The North Carolina Wildlife Resources Commission (WRC) has expressed the preference for a maximum island size limit for Wells and Parnell disposal islands, which are located along Old House Channel. These disposal islands also serve as bird sanctuaries. Due to frequent dredging needs in the vicinity of these islands, both sites currently are at or exceed established limits. The WRC has asked that both sites be used on a less frequent 2-3 year disposal cycle to allow time for natural erosion to reduce the size of the islands, minimizing the potential for establishment of avian predators (US ERDC, 2008).

5.2 Assessment of Problems, Opportunities, Objectives and Constraints

5.2.1 Problems and Opportunities

This section describes the public concerns in the context of problems and opportunities that can be addressed through water and related land resource management. Solving these problems and opportunities provides basis for motivating & allocating the partners' pooled resources (Planning Manual, pg. 78).

1) The problem identified in this CAP Section 204 study is a historic loss of oyster reef habitat in Pamlico Sound, NC. Due to the importance of oysters as a keystone species in estuarine ecosystem health (Street et al., 2005; Peterson et al., 2003; NCDMF, 2009) and their sharp decline in population in North Carolina from historic levels (Ortega & Sutherland, 1992), the State of North Carolina has made oyster restoration a high priority as expressed in the Blue Ribbon Report (Frankenberg, 1995). Due to historic overharvesting, destruction of habitat, pollution and disease, oyster landings are estimated to be only ten percent of what they were just over a century ago (Ortega & Sutherland, 1992). According to NCDMF 2001a, the primary cause of initial oyster reef decline and degradation in Pamlico Sound was the introduction and use over time of the "oyster dredge" as a harvesting practice. First introduced in 1889, the practice of oyster dredging involves a boat pulling a large rake along the sea floor (particularly over oyster reefs), bringing up the oysters in it's path. Oyster dredging is still in practice today, but with restrictions. A decline in oyster habitat from historical levels in the Pamlico Sound is viewed as a concern by both public and private entities.

2) There are opportunities in the study area to restore oyster reef habitat. This would contribute to local, state, and national goals of restoring the oyster population in North Carolina waters. Successful establishment of oyster reefs in the project vicinity has been demonstrated by the State of North Carolina (see Section 3.2).

5.2.2 Planning Objectives

These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions. The planning objectives are:

1. Contribute to State network of self-sustaining oyster reefs in Albemarle-Pamlico National Estuary as described by the NCORSC's Oyster Restoration and Protection Plan.

2. Increase acreage of oyster reefs in Pamlico Sound, NC by 5 to 20 acres. This range is considered appropriate based on anticipated dredged material volumes.

5.2.3 Planning Constraints

Study-specific constraints that will guide formulation and screening of alternatives include:

a. Avoid disturbing existing high value areas (site construction & pipe placement)
   Site construction and related activities must avoid existing SAV, shell bottoms, and cultural resources. This risk is being minimized through a detailed survey of the project study area.

b. Avoid conflicting with other area fisheries such as crab trawling
   This risk is being minimized through coordination with local field experts & NCDMF as a liaison to the fishing community.

c. Avoid sand quality that is inappropriate for beneficial use, and sediment material inappropriate for foundational support.
   The risk is being minimized through geotechnical vibracore sampling.

d. Avoid alternatives requiring mitigation.

e. Avoid removing material directly from Wells and Parnell Disposal Islands for construction material.

f. Ensure a 7 foot navigation clearance is maintained above any structural plans that create oyster reefs(*Based on State of North Carolina policy).*

5.3 Potential Restoration Alternatives

This section describes the Alternative development for a beneficial use of dredged material project at Old House Channel. A number of general measures were identified that would meet one or more of the planning objectives. These measures underwent a preliminary screening process. The retained measures were evaluated and then further developed into alternatives.

5.3.1 Description of Measures

A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A variety of measures were considered, some

of which were found to be infeasible due to technical, economic, or environmental constraints. Each measure was assessed and a determination made regarding whether it should be retained in the formulation of alternative plans. The descriptions and results of the evaluations of the measures considered in this study are presented below, and described afterwards:

1. **NO ACTION**
2. Beach Placement on Cape Hatteras National Seashore or Pea Island National Wildlife Refuge
3. Additional Bird Island Creation
4. Marsh Protection
5. Oyster Reef Construction

1. **No Action**. The USACE is required to consider the option of "No Action" as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). No Action assumes that no project would be implemented by the Federal Government to achieve planning objectives. No Action, which is also referred to as the "Without Project Conditions", forms the basis from which all other alternative plans are measured. Under the No-Action plan, the USACE would do no restoration efforts at Old House Channel, and the base plan for managing dredged material would remain in place. State efforts to meet Local, State, & National goals for oyster restoration in Pamlico Sound would be expected to continue, but without restoration in the identified area of need of Old House Channel. Strain on Wells & Parnell disposal islands, as well as disposal island MN would continue without any alleviation from an alternative disposal option.

2. **Beach Placement on Cape Hatteras National Seashore or Pea Island National Wildlife Refuge.** This measure would require pumping dredged material from Old House Channel to the closest beach (roughly 5 miles away) for shoreline placement. This would divert material from Wells and Parnell disposal islands. The National Parks Service (NPS) is responsible for Cape Hatteras National Seashore, which is north of Oregon Inlet. The NPS has stated that it is highly unlikely that they would permit the deposition of dredged spoils on the National Seashore property at this location. The USFWS is responsible for Pea Island National Wildlife Refuge, south of Oregon Inlet. Dredged material from Oregon Inlet is already being deposited on Pea Island as part of dredging operations. Further negotiation with the USFWS would be needed to gain permission to place material from the interior channels of the Manteo (Shallowbag) Bay navigation project, which includes Old House Channel (Range 2).

3. **Additional Bird Island Creation.** Dredged material from Old House Channel could be used to create another disposal island that could also be used as additional bird habitat. Two existing bird islands (Wells &

Parnell islands) already exist in the project area. A separate Dredged Material Management Plan study is currently investigating the creation of additional bird islands. However, this conversion of aquatic to terrestrial habitat would not address identified oyster restoration needs.

4. **Marsh Protection.** Dredged material could be used to protect marsh, similar to the USACE project constructed at Festival Park near Manteo. However, the nearest shoreline is approximately 5 miles away, and there has been no documented need of marsh protection in the vicinity.

5. **Oyster Reef Construction.** Dredged material from maintenance dredging of Old House Channel could be used to build submerged sand islands to be topped with cultch (hard substrate for oyster larvae attachment) for oyster reefs, with various reef configurations being considered. Configurations could include placing sand in submerged enclosures where good oyster growing conditions are found near the navigation channel and where submerged aquatic vegetation (SAV) or other significant resources do not exist.

5.3.2 Preliminary Screening of Restoration Measures

Two rounds of preliminary screenings were used before a final array of alternatives was moved forward to detailed analysis and evaluation. Costs and benefits are not computed at this preliminary screening stage. Conclusions of the screening pertain to this Section 204 Study and related objectives and oyster reef restoration, and do not preclude other viable options of dredged material disposal which may be identified for the larger Manteo (Shallowbag) Bay Dredging Project.

Preliminary Screening–Round 1. All of the measures under consideration were initially screened based on a number of factors including contribution to planning objectives, technical feasibility, economic feasibility, environmental acceptability, and mitigation requirements. Based on these factors, determinations were made regarding which measures to proceed forward with to the second round of screening. This preliminary screening process is summarized in Table 5.01.

Table 5.01 First Array for Evaluation and Screening of Measures/Alternatives. One or more carried forward to Second Array, Table 5.02

	Possible Measures	Planning Objectives			Planning Constraints					Carried Forward
		Contribute to State network of self-sustaining oyster reefs in APES as described iby NORSC's Oyster Restoration and Protection Plan	Increase acreage of oyster reefs in Pamlico Sound, NC by 5 to 20 acres	Divert dredged material from Wells & Parnell disposal islands.	Avoid alternatives requiring mitigation (source: *June 17, 1994 Planning Division Summary Report*)	Technically feasible	Environmentally acceptable	Economically feasible	Violates Authority	
	No Action	Does not contribute to planning objectives	Does not contribute to planning objectives	Does not contribute to planning objectives	N/A	N/A	N/A	N/A	N/A	**YES**
	Beach placement	This would not contribute to a Network of self-sustaining oyster reefs.	Would not increase oyster reef acreage in Pamlico Sound.	Would provide alternative disposal option to Well's & Parnell Islands.	No known mitigation required.	Pumping distance far (5 miles), but still technically feasible.	Cape Hatteras National Sea shore looks unfavorably at shoreline disposal. Pea Island already receiving sand from Oregon Inlet.	Pumping distance (5 miles) far, but disposal method requires no additional construction materials.	Does not violate authority.	**NO** (does not address identified problem/pumping distance/national seashore restrictions)
	Bird island creation	This would not contribute to a Network of self-sustaining oyster reefs.	Would not increase oyster reef acreage in Pamlico Sound.	Would provide alternative disposal option to Well's & Parnell Islands.	Conversion of aquatic to terrestrial habitat would require mitigation (June 17, 1994 Planning Division Summary Report).	Bird islands have already been constructed and are technically feasible.	While creating bird nesting habitat, island creation also removes aquatic habitat. This has resulted in the request by NCDMF for mitigation for estuarine bottom raised above high water.	Island creation would be very economically efficient.	Does not violate authority.	**NO** (does not address identified problem/requires mitigation)
	Marsh protection	Although a hard-structure feature in marsh protection could support some oyster growth, the amount would not constitute contribution to described reef network.	Acreage of oysters created, if any, would not meet the planning objective of 5 to 20 acres.	Would provide alternative disposal option to Well's & Parnell Islands, although quantities are unknown.	No known mitigation required.	This has been accomplished at Festival Park.	It is environmentally acceptable to protect threatened marsh & wetlands.	Economic feasibility would partly depend on pumping distance to the nearest marsh that needed protection. However, there are no documented needs in the project vicinity.	Does not violate authority.	**NO** (does not address identified problem/ no identified need in project vicinity)
	Oyster reef construction	Creation of one to several oyster reefs in identified area would contribute to network as described by NORSC.	YES	The use of dredged material from Old House Channel (Range 2) for the creation of oyster reefs would alleviate strain on Well's & Parnell Islands for one to two dredging cycles.	Would be considered an enhancement of aquatic habitat and would not require mitigation.	There are viable methods for submerged oyster reef contruction using dredged material.	Oysters are considered a keystone species in the aquatic ecosystem. Their decline has been documented, and restoration is seen as a priority by multiple agencies.	Oyster reef construction can be achieved within the Authority's cost limits.	Does not violate authority.	**YES** (addresses both identified problem and opportunity/ does not violate any planning constraints)

Carried Forward | Eliminated | Fully Meets Obj/Constraint | Partially Meets Obj/Constraint | Does Not Meet Obj/Constraint

Preliminary Screening – Round 2. Based on the first round of preliminary screening, oyster reef construction was carried forward to a second array of measures for evaluation and screening. As shown in Table 5.02, various configurations and methodologies of oyster reef construction were considered and screened based on the same criteria used in the first round of preliminary screening. A *traditional rock reef* such as the State has used was screened out because it does not use dredged material as required by the 204 Authority. *Uncontained sand mounds* were screened out as an option due to concerns of dredged material migration after placement from currents in the area, particularly during significant storm events such as Nor'easters and tropical activity. There is also opposition to unconfined disposal from resource agencies. Sandbag reef alternatives were also screened out due to uncertainty regarding the feasibility of placement and filling of sandbags in deep water. Both *stone contained* and *sheetpile & stone contained* reefs were carried forward for detailed design and evaluation.

Table 5.02 Second Array for Evaluation and Screening of Measures/Alternatives. One or more carried forward to detailed design and evaluation.

	Possible Measures	Planning Objectives			Planning Constraints					
	VARIOUS OYSTER REEF CONFIGURATIONS:	Contribute to State network of self-sustaining oyster reefs in APES as described iby NORSC's Oyster Restoration and Protection Plan	Increase acreage of oyster reefs in Pamlico Sound, NC by 5 to 20 acres	Divert dredged material from Wells & Parnell Disposal Islands.	Avoid alternatives requiring mitigation	Technically feasible	Environmentally acceptable	Economically feasible	Violates Authority	Carried Forward
	Traditional Rock Reef	Would contribute to reef network.	Increased cost may limit buildable acreage to less than 5 acres.	No use of dredged material.	No known mitigation required.	State has demonstrated technical feasibility.	Oysters are considered a keystone species in the aquatic ecosystem. Their decline has been documented, and restoration is seen as a priority by multiple agencies.	Use of more rocks would increase costs when considering cost limits under this authority.	No use of dredged material.	**NO** (Violation of Authority because an "all rock" reef would not use dredged material)
	Sand-Based Reefs:									
	Uncontained sand mounds (Unarmored)	Instability of reefs due to uncontainment and currents could jeopardize establishment of oysters.	Instability of reefs due to uncontainment and currents could jeopardize establishment of oysters.	Dredged material would be disposed of in oyster reef core for 1 to 2 dredging cycles.	No known mitigation required.	Due to uncontainment and currents, sand would not stay in place to cultch.	Issues with Environmental Acceptability due to the uncontained nature of the reef. Agencies could consider this method simply "unconfined dumping" of dredged material. NCDMF has asked that created reefs be contained.	Least costly alternative due to the lack of a rock containment structure.	Does not violate authority.	**NO** (Instability due to uncontainment would jeopardize integrity & effectiveness. Environmental acceptability questionable)
	Contained sand mounds (Sand Bags)	Would contribute to reef network .	Likely to increase oyster acreage to meet objective.	Dredged material would be disposed of in oyster reef core for 1 to 2 dredging cycles.	No known mitigation required.	Significant technical challenges to properly placing submerged sandbags as reef containment. Longevity issues with containment.	Oysters are considered a keystone species in the aquatic ecosystem. Their decline has been documented, and restoration is seen as a priority by multiple agencies.	Shorter life expectancy increases life cycle O&M costs if containment is maintained.	Does not violate authority.	**NO** (technical challenge of submerged sandbag placement; issues with longevity of containment)
	Contained sand mounds (Stone)	Would contribute to reef network .	Likely to increase oyster acreage to meet objective.	Dredged material would be disposed of in oyster reef core for 1 to 2 dredging cycles.	No known mitigation required.	Reef configuration technically feasible.	Oysters are considered a keystone species in the aquatic ecosystem. Their decline has been documented, and restoration is seen as a priority by multiple agencies.	This is an economically feasible alternative.	Does not violate authority.	**YES**
	Contained sand mounds (Sheetpile & Stone)	Would contribute to reef network.	Likely to increase oyster acreage to meet objective.	Dredged material would be disposed of in oyster reef core for 1 to 2 dredging cycles.	No known mitigation required.	Reef configuration technically feasible; however, there is increased challenge anticipated with driving sheetpile evenly.	Same as sandbag & stone alternatives immediately above.	This is an economically feasible alternative.	Does not violate authority.	**YES**
	NO ACTION	Does not contribute to planning objectives	Does not contribute to planning objectives	Does not contribute to planning objectives	N/A	N/A	N/A	N/A	N/A	**YES**

Carried Forward | Eliminated | Fully Meets Obj/Constraint | Partially Meets Obj/Constraint | Does Not Meet Obj/Constraint

5.3.3 Final Array of Alternatives

With those management measures or plans that survived the above screening process, a final array of alternatives was formulated. Based on the initial screenings, the measures or plans that will be carried forward include no-action, as well as two sand-based oyster reef construction methodologies: stone containment, and sheetpile and stone containment. For each construction methodology, various sizes and configurations were developed as alternatives. The largest reef sizes/configurations were designed to contain approximately all of the anticipated dredged material from one dredging cycle along Old House Channel (Range 2) (i.e. roughly 180,000 cubic yards (cy)). The estimated dredging cycle volume is based on the average pay quantity (209,000 cy) removed from Old House Channel (Range 2) for the most recent 3 dredging contracts. It was assumed that during dredging of 209,000 cy of material there would be 15% losses with only 177,650 cy ending up in the containment area. In addition, arrays of smaller reef sizes/configurations were also developed for consideration. Each of the final plans will utilize dredged material form Old House Channel (Range 2) for oyster reef restoration. Any excess material not utilized in reef construction would be pumped to one of the nearby disposal islands.

OLD HOUSE CHANNEL (RANGE 2) DREDGING VOLUMES

Dredging Cycles Prior to 2012

Source: USACE Wilmington District Navigation Branch Dredging Records

Year	Months	Quantity, cubic yards
2004	April – July	230,671
2006	March – May	176,815
2008 - 2009	October 2008 – January 2009	219,304

Site Selection

The following steps were undertaken to identify an appropriate placement site for oyster reef placement. This is illustrated in Figure 5.01.

Step 1:
An initial 17-square-mile project study area was chosen based on its vicinity to State oyster restoration efforts, and identified dredged material disposal needs from Old House Channel (Range 2).

Step 2:
A bathymetric and multi-beam sidescan sonar survey of the project study area was conducted by the USACE-ERDC field research facility at Duck, N.C. to map existing resources and topography of the area (USACE-ERDC, 2009).

Step 3:
To identify an appropriate placement site for submerged oyster reef construction, several screening criteria were used:

1. Avoid disturbing existing high value areas (wetlands, SAVs, or existing shellbottom)
2. Water depth must be sufficient enough to allow 7 feet navigation clearance above reef top (based on State of NC Policy).
3. Avoid conflict with other area fisheries, such as crab trawling
4. Placement site must contain enough sand to support the reef structure

Using the data collected from the ERDC boat survey, screening criteria were applied using GIS mapping. The specific criteria used for the initial screening of potential placement areas were:

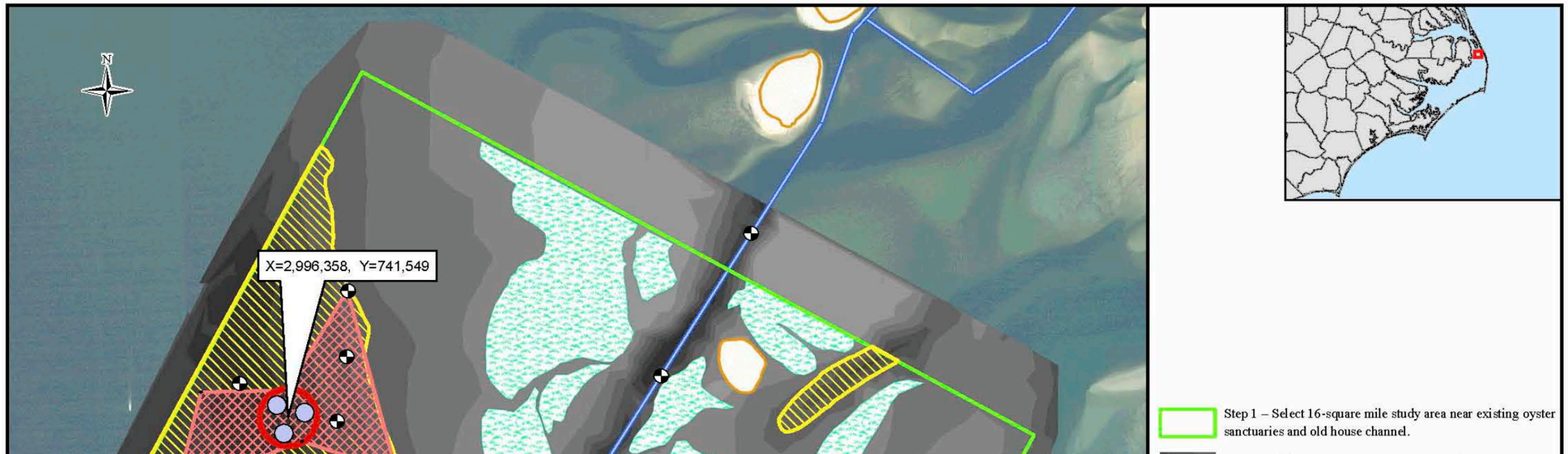
a. Eliminate areas with existing SAV
b. Eliminate areas with existing shellbottom
c. Eliminate areas with depth shallower than 11 feet

Step 4:
A vibracore drilling plan to analyze sediment characteristics was developed for the remaining area that passed the initial screening phase. However, the slough in the North East quadrant of the project study area was eliminated from consideration due to inaccessibility for vibracore drilling due to the surrounding shallows. Figure 5.01 depicts one boring in the southeastern portion of the project study area outside of the designated geotechnical survey area which was conducted as a subsurface exploratory investigation only. The two additional borings in the southern portion of the project study area were within a smaller designated geotechnical survey area during initial investigations.

Step 5:
Based on the results from the vibracore analysis (Section 4.6 and Appendix E), the potential placement area was narrowed down further to areas considered to have suitable sediment material for placement (sandy bottom areas considered of lower biological productivity to provide structural support of construction foundations).

Step 6:
Surface sediment sampling was conducted within the suitable foundation area to verify the absence of wintering crab habitat. The final placement site will occur within this sampling zone.

Figure 5.01 Map of Site Selection Screening Process



Each of the alternatives will utilize dredged material from Manteo Old House Channel Range 2 for creation of a submerged oyster reef habitat. A containment structure will be constructed to contain the dredged material. Several containment structure alternatives were evaluated. The final arrays of alternatives are listed in Table 5.03 and are discussed in the following paragraphs.

Table 5.03
Final Array of Alternatives

Alt	Containment Structure	# of Cells	Area (acre)	Capacity (cy)
1	None/No Action	n/a	n/a	n/a
2	Sheetpile w/Stone Apron	1	18.6	179,500
3	Sheetpile w/Stone Apron	1	15.06	144,100
4	Sheetpile w/Stone Apron	1	9.7	90,800
5	Sheetpile w/Stone Apron	2	2x9.7 = 19.4	181,600
6	Sheetpile w/Stone Apron	1	5.07	45,500
7	Sheetpile w/Stone Apron	2	2x5.07 = 10.14	91,000
8	Sheetpile w/Stone Apron	3	3x5.07 = 15.21	136,500
9	Sheetpile w/Stone Apron	4	4x5.07 = 20.28	182,000
10	Stone Sill	1	18.6	178,600
11	Stone Sill	1	15.06	143,290
12	Stone Sill	1	9.7	90,100
13	Stone Sill	2	2x9.7 = 19.4	180,200
14	Stone Sill	1	5.07	45,000
15	Stone Sill	2	2x5.07 = 10.14	90,000
16	Stone Sill	3	3x5.07 = 15.21	135,000
17	Stone Sill	4	4x5.07 = 20.28	180,000

Alternative 1 – No Action.

The USACE is required to consider the option of “No Action” as an alternative in order to comply with the requirements of the National Environmental Policy Act (NEPA). No Action assumes that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. No Action, which is synonymous with the Without Project Conditions, forms the basis from which all other alternative plans are measured. Under the no-action plan, the USACE and the Sponsor would not make use of dredged material from Old House Channel (Range 2) for oyster reef restoration. Instead, all material from future dredging events would continue to be placed on disposal islands within the vicinity, with the location likely being either islands Wells, Parnell, or MN. No oyster habitat would be created. Although the North Carolina Oyster Restoration Steering Committee has recognized the project study area as an area of need for oyster restoration, there are currently no other plans for reef restoration in addition to the *Manteo, Old House Channel, NC Section 204* study.

Alternative 2 – one 18.6 acre site with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using composite sheetpile to create one 18.6 acre containment area for dredged material. An 18.6 acre containment area would be able to contain approximately 179,500 cubic yards of dredged material. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9"-23"). Bedding stone for the armor stone would be NCDOT Class B stone (5"-12"). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone (2"-6") and oyster shell to provide habitat for establishment of oysters. A typical cross section is shown in Figure 5.02.

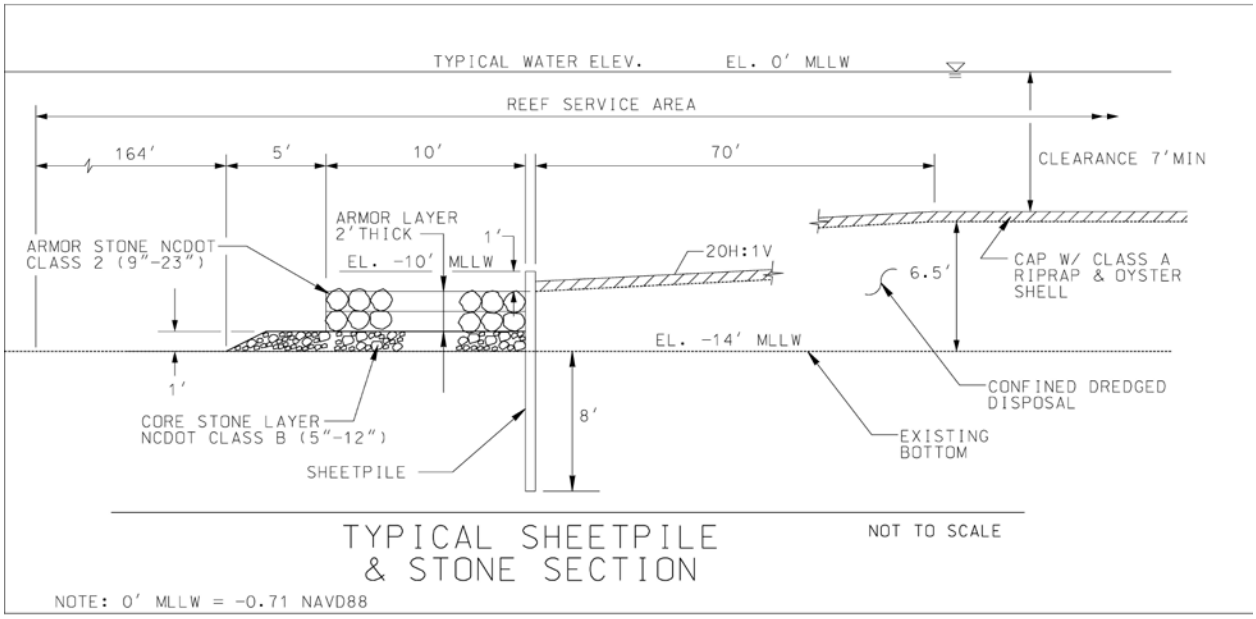


Figure 5.02. *Typical Sheetpile & Stone Cross Section for Alternatives 2 – 9.*

Alternative 3 – one 15.06 acre site with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create one 15.06 acre containment area for dredged material. A 15.06 acre containment area would be able to contain approximately 144,100 cubic yards of dredged material. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9"-23"). Bedding stone for the armor stone would be NCDOT Class B stone (5"-12"). Dredged material from

maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 4 - one 9.7 acre site with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create one 9.7 acre containment area for dredged material. A 9.7 acre containment area would be able to contain approximately 90,800 cubic yards of dredged material. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 5 – Two 9.7 acre sites with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create two 9.7 acre containment areas for dredged material. Two A 9.7 acre containment areas would be able to contain a total of approximately 181,600 cubic yards of dredged material. The two separate containment areas would be constructed in close proximity of each other. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 6 – One 5.07 acre site with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create one 5.07 acre containment area for dredged material. A 5.07 acre containment area would be able to contain approximately 45,500 cubic yards of dredged material. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 7 – Two 5.07 acre sites with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create two 5.07 acre containment areas for dredged material. Two 5.07 acre containment areas would be able to contain a total of approximately 91,000 cubic yards of dredged material. The two separate containment areas would be constructed in close proximity of each other. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 8 – Three 5.07 acre sites with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create three 5.07 acre containment areas for dredged material. Three 5.07 acre containment areas would be able to contain a total of approximately 136,500 cubic yards of dredged material. The three separate containment areas would be constructed in close proximity of each other. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The sheetpile would be driven into the bottom to provide a 4-foot height above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 9 – Four 5.07 acre sites with sheetpile and stone combination containment structure.

This alternative would involve creation of oyster habit by using a composite sheetpile to create four 5.07 acre containment areas for dredged material. Four 5.07 acre containment areas would be able to contain a total of approximately 182,000 cubic yards of dredged material. The four separate containment areas would be constructed in close proximity of each other. The sheetpile would be driven into the bottom with a resulting top of sheetpile elevation 4 feet above the sea floor. The outside perimeter of the sheetpile wall would be protected with NCDOT Class 2 armor stone (9”-23”). Bedding stone for the armor stone would be NCDOT Class B stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped

into the containment areas. The dredged material would be covered with NCDOT Class A stone (2”-6”) and oyster shell to provide habitat for establishment of oysters.

Alternative 10 – one 18.6 acre site with 4-foot stone sill containment structure.

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create one 18.6 acre containment area for dredged material. An 18.6 acre containment area would be able to contain approximately 178,600 cubic yards of dredged material. The core portion of the containment structure would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters. A typical cross section is shown in Figure 5.03.

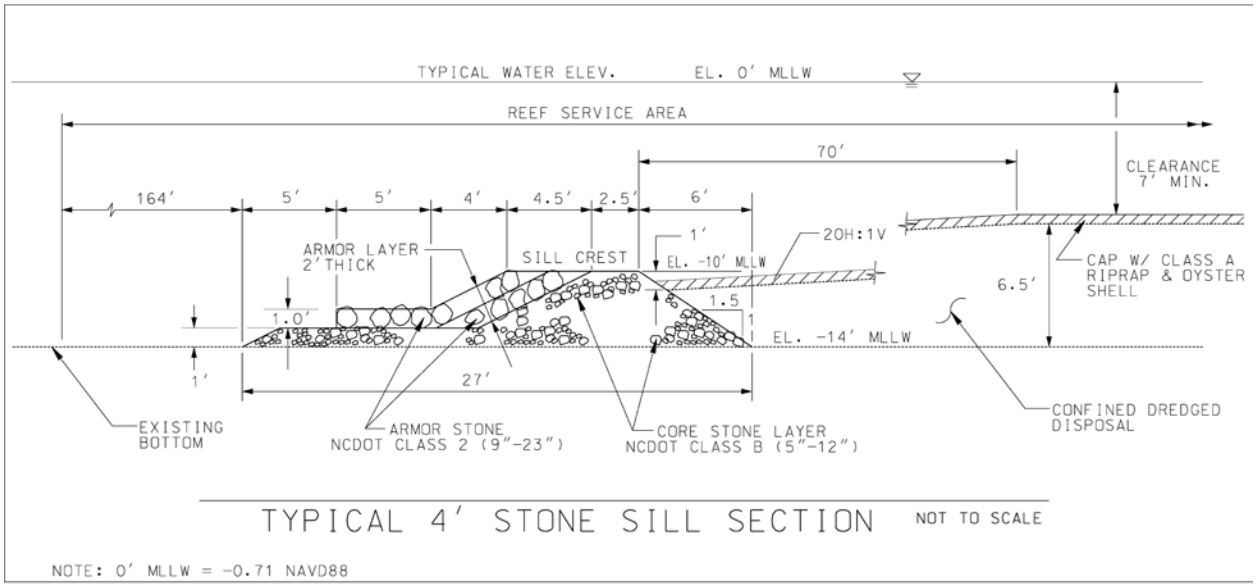


Figure 5.03. *Typical Stone Cross Section for Alternatives 10 – 17.*

Alternative 11 – one 15.06 acre site with 4-foot stone sill containment structure.

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create one 15.06 acre containment area for dredged material. A 15.06 acre containment area would be able to contain approximately 143,290 cubic yards of dredged material. The core portion of the containment structure would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 12 – one 9.7 acre site with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create one 9.7 acre containment area for dredged material. A 9.7 acre containment area would be able to contain approximately 90,100 cubic yards of dredged material. The core portion of the containment structure would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 13 – Two 9.7 acre sites with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create two 9.7 acre containment areas for dredged material. Two 9.7 acre containment areas would be able to contain a total of approximately 180,200 cubic yards of dredged material. The two separate containment areas would be constructed in close proximity of each other. The core portion of the containment structures would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 14 – One 5.07 acre site with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create one 5.07 acre containment area for dredged material. A 5.07 acre containment area would be able to contain approximately 45,000 cubic yards of dredged material. The core portion of the containment structure would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment area. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 15 – Two 5.07 acre sites with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create two 5.07 acre containment areas for dredged material. Two 5.07 acre containment areas would be able to contain a total of approximately 90,000 cubic yards of dredged material. The two separate containment areas would be constructed in close proximity of each other. The core portion of the containment structures would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be

covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 16 – Three 5.07 acre sites with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create three 5.07 acre containment areas for dredged material. Three 5.07 acre containment areas would be able to contain a total of approximately 135,000 cubic yards of dredged material. The three separate containment areas would be constructed in close proximity of each other. The core portion of the containment structures would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

Alternative 17 – Four 5.07 acre sites with 4-foot stone sill containment structure

This alternative would involve creation of oyster habitat by constructing a stone sill made of NCDOT Class 2 armor stone (9”-23”) to create four 5.07 acre containment areas for dredged material. Four 5.07 acre containment areas would be able to contain a total of approximately 180,000 cubic yards of dredged material. The four separate containment areas would be constructed in close proximity of each other. The core portion of the containment structures would be constructed of NCDOT Class B Stone (5”-12”). Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters.

5.4 Comparison of Alternatives

5.4.1 "Base Plan" Costs

Under the Section 204 Authority, costs of beneficial use of sediment projects are limited solely to construction costs that are in excess of the Base Plan (normal dredging costs without the project). As a result, the costs used for evaluation and comparison purposes are the incremental costs of the potential ecosystem restoration plans over the cost associated with disposing of the sediments as described in the Base Plan. In the case of Manteo, Old House Channel, the costs used for evaluation/comparison purposes are the costs by which the construction costs exceed the cost of dredging of materials from Old House Channel (Range 2) and disposal on the designated disposal area (typically either Wells, Parnell, or island MN). Since there are different quantities of dredged material associated with different alternatives, certain alternatives will be compared to a different "base plan" cost. Each of these different plans will include the costs of mob/demob, dredging of the sediments, and transportation and disposal of the sediments at the designated disposal area. These costs were developed by the Wilmington District Cost Engineering Team based on Regional Sediment Management (RSM) system data from the most recent dredging event at Manteo Old House Channel (2008). The lowest bidder cost in 2008 was $6.34 per cubic yard (CY). Using escalation rates from October 2008 to October 2014 gives a rate of 105.4%. This inflates the price to $6.68. Adjusting fuel costs another $0.32 would bring the costs for dredging to $7.00 per CY. This figure was used to estimate the base plan costs below. The "base plan" costs for each alternative are shown in Table 5.04.

Table 5.04. *Base Plan Costs for Manteo, Old House Channel, NC*

Base Plan Costs for Manteo 204

Alternative	Cubic yards*	Total Costs
Alternatives 2,5,9,10,13,&17	180,000	$1,260,000
Alternatives 3&11	144,000	1,008,000
Alternatives 4&12	90,000	630,000
Alternatives 6&14	45,000	315,000
Alternatives 7&15	91,000	637,000
Alternatives 8&16	135,000	945,000

*Cubic yards for each set of alternatives in table are rounded for grouping purposes.

5.4.2 Costs of Alternatives

Table 5.05. Costs of Alternatives

Alternative	Estimated Cost	Average Annual Cost
No Action		$0.00
2	$9,492,913	$459,573.00
3	$8,221,938	$398,042.00
4	$6,202,513	$300,277.00
5	$11,286,353	$545,526.00
6	$4,304,592	$208,395.00
7	$7,473,198	$361,794.00
8	$10,641,804	$515,193.00
9	$13,810,410	$668,192.00
10	$7,024,596	$340,0767.00
11	$5,999,991	$290,473.00
12	$4,425,449	$214,146.00
13	$7,718,010	$373,646.00
14	$3,024,840	$146,439.00
15	$4,916,793	$238.033.00
16	$6,804,659	$329,429.00
17	$8,695,469	$420,967.00

5.4.3 Ecological Output Analysis of Alternatives

Introduction. Environmental Benefits Assessment (EBA) is used to measure the increase in both the quality and quantity of a targeted ecosystem due to various proposed restoration measures and alternatives at a site. For the Manteo 204 study, quality was measured in terms of a Habitat Suitability Index (HSI). The HSI is multiplied by the number of acres being restored in order to generate a “Habitat Unit (HU)” as output. The greater the number of Habitat Units the greater the ecological benefit.

The following sections contain detailed description of the application of the Oyster HEP model.

Habitat Evaluation Procedure (HEP). Estuarine reefs were evaluated using a USFWS Habitat Evaluation Procedure (HEP). The Eastern oyster (*Crassostrea virginica*) was the target species since a healthy oyster population is considered a keystone indicator of the ecological health of the estuary (NCDMF, 2001 and Frankenberg, 1995). Oysters

are ecosystem engineers (Jones et al., 1994) where oyster growth and recruitment is required for reef sustainability and expansion.

Habitat Suitability Index (HSI) Model. The Habitat Suitability Index (HSI) Model: Gulf of Mexico American Oyster developed by the US Fish and Wildlife Service (Cake, 1983) was applied (American oyster is synonymous with Eastern oyster). This model was developed for the Gulf of Mexico with application in Atlantic Coast habitats south of Cape Hatteras. The oyster habitat of the Pamlico Sound where the project would be located area is similar to that of the Gulf of Mexico, in that it supports subtidal oysters (Eastern oyster (*Crassostrea virginica)*) in waters that are less than 33 feet deep with a small tide range. This site is 35 miles north of Cape Hatteras so oyster life requisites measured by model variables were confirmed as appropriate for this analysis by review of literature regarding Atlantic coast oyster populations (Kennedy et al., 1996). Oyster sampling by NC State University at nearby (< 5 miles) NCDMF Crab Hole Sanctuary further confirm high potential for oyster establishment in the project vicinity.

Variables and Formulas. This HSI model has a larval and an adult component and assesses 6 variables to define Habitat suitability. The variables measure reef structure, water column conditions, and oyster abundance to determine site suitability for both larvae (Table 5.06, Variables 1-3) and adult oysters (Table 5.07, Variables 4-6).

Habitat suitability was calculated as explained below. The model specifically measures habitat suitability for oysters; however, for this application oysters are considered a keystone species supporting, and therefore serving as an indicator of, the wide array of estuarine functions. One associated function is support of fishery resources on and in subtidal bottoms adjacent to the reef structure. Studies have shown that significant increases in the numbers of fish and species richness would also occur in adjacent soft bottom areas extending 50 -100 meters away from the reef (dos Santos et al. 2010). Therefore a conservative 50m perimeter service area, to be demarcated by corner buoys and protected by sanctuary designation is included as a component of this project. As an established oyster sanctuary, the reef and adjacent (service area) soft bottom habitats and resident fauna, would be protected from future harvest and bottom disturbance. The HSI of this area, as a function of proximity of the reef, is assumed to be equal to that of the reef immediately adjacent and diminishing to a conservative theoretical 0, at a distance 50 meters away from the toe of the reef structure.. For this analysis the average HSI of the reef service area is calculated as Service Area HSI = (HSI for the reef adjacent parameter + HSI at 50m (0))/2 (Cake, 1983).

Table 5.06. *HSI Variables to Assess Suitability for Oyster Larvae.*

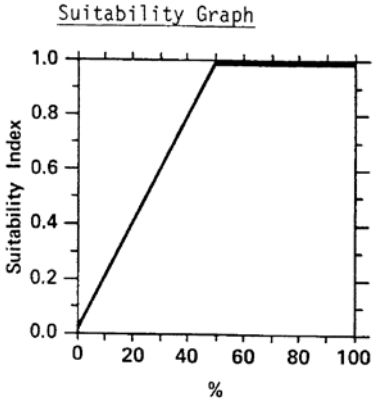
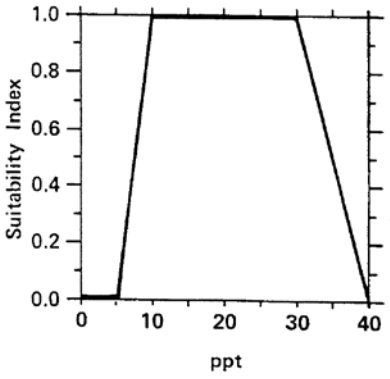
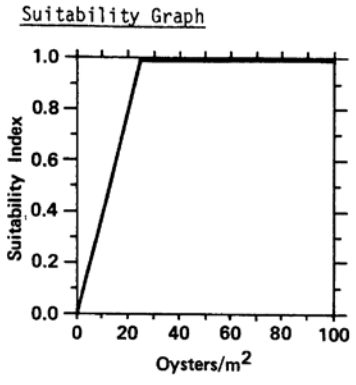
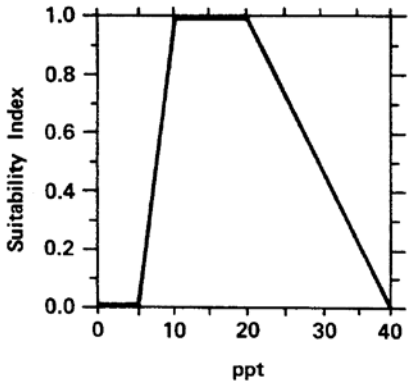
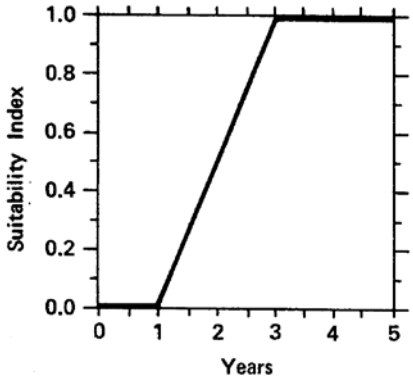
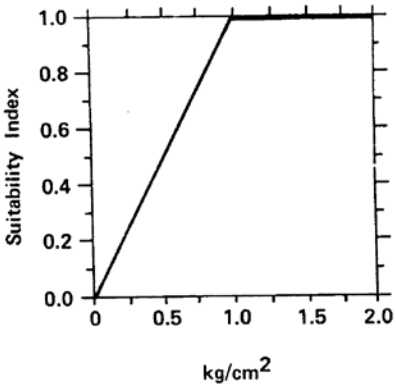
HSI Variables for Suitability for Oyster Larvae			
FUNCTION	VARIABLE	DATA SOURCE	HSI Graph (Cake 1983)
Support larval attachment	V1 Percent suitable cultch	Existing Condition Side ERDC Scan Survey Report (2009) Future Conditions from design	
Water quality support for oyster larvae	V2 Mean summer salinity (ppt)	NCSU Crab Hole Monitoring Data 2006-2008 &NC Shellfish Sanitation Oregon Inlet Fishing Center Monitoring Data 2006-2010	
Biological support for larvae	V3 Mean abundance of living oysters /M^2	NCSU Crab Hole Monitoring Data 2006-2008	

Table 5.07. *HSI Variables to Assess Suitability for Adult Oysters.*

HSI Variables for Suitability for Adult Oysters			
FUNCTION	VARIABLE	DATA SOURCE	HSI Graph
Water column support adult oysters	V4 Historic mean salinity (ppt)	NCSU Crab Hole Monitoring Data 2006-2008 &NC Shellfish Sanitation Oregon Inlet Fishing Center Monitoring Data 2006-2010	
Avoidance of killing conditions	V5 Frequency of killing events/period of record)	NCSU Crab Hole Monitoring Data 2006-2008 &NC Shellfish Sanitation Oregon Inlet Fishing Center Monitoring Data 2006-2010	
Structural support for adult oysters	V6 Substrate firmness (hard or soft). Areas >80% sand = 0	Existing and Without Project Geotechnical Appendix With Project Conditions from Proposed Design	

The HSI, representing habitat quality, was multiplied by the available habitat quantity, for reef service area to determine output measured in Functional Units.

1. CI_L Larvae HSI $=(V_1 \text{ X } V_2 \text{ X } V_3)^{1/3}$ if $V_3=0$ $(V_1 \text{ X } V_2)^{1/2}$
2. CI_A (Adult HSI) $=(V_4 \text{ X } V_5 \text{ X } V_6)^{1/3}$ if $V_6=0$ $CI_A=0$
3. Oyster HSI If CI_A is$<CI_L$ HSI$=CI_A$, if $CI_A>CI_L$ HSI $=(CI_A \text{ X } CI_L)^{1/2}$

Service Area HSI Calculation:
Service Area HSI = (HSI for the reef adjacent perimeter + HSI for the +50m perimeter)/2.

Existing and Future Without Project Conditions. The area proposed for reef development is existing sandy estuarine bottom. Existing deep water sandy bottoms lack suitable cultch and cannot support oyster reefs without the addition of structure and cultch. The HSI model provides an index of 0 if the bottom substrate is composed of 80% or more sand. The existing absence of shell bottom and sandy bottom sediment in the project foot print has been confirmed by side scan survey and sediment analysis. No plans exist to build reefs in this area; therefore the future condition without a Federal project is status quo. Existing sandy soft bottom habitats are currently remote (beyond 100m) to reef structure and currently do not function as a reef and soft bottom complex. The sites lack hard structure and are subjected to reoccurring impacts to benthic resources from trawling. These bottoms currently have no potential to establish reef habitat and were considered to generate 0 benefits under the without project condition.

Computation of Habitat Suitability Index. The proposed project includes the construction of new high output reef areas that would be identified by a series of buoys for designation as a sanctuary. As sanctuary, these sites would be managed by NCDMF to preclude oyster harvest and trawling. Recreational fin-fishing by hook and line is allowed. This measure would expand on an existing successful practice that has developed a complex including nine Oyster Sanctuaries throughout the Pamlico Sound. This site is located between two existing NCDMF sanctuaries including 1) Croatan Sound Sanctuary an 8 acre sanctuary established in 1996, including 1,800 tons of riprap, oyster shells surf clam shells and limestone marl and, 2) Crab Hole a 30.5 acre sanctuary including 37, 00 tons of riprap that are within a 3 mile radius of the proposed site and should be benefited by an additional supply of larvae once the new reefs become populated by oysters.

The site location was optimized considering pumping distance from the Old House Channel, and bottom conditions to assure foundational stability and to avoid existing biological resources. Mud bottoms (preferred crab harvest areas), SAV and existing shell bottoms were avoided. The proposed location is shown in Figure 5.01. It is assumed that any location within this identified area would have equal suitability for oyster growth and sustainability and only one HSI for the existing, future without, and future with condition was calculated.

Table 5.08. *HSI Computations based on HEP.*

HSI Computations Based on HEP

USFWS OYSTER HSI MODEL (CAKE, 1983)	V1 Substrate Index	V2 Mean Sum Salinity Index Values	V3, Gregarious Factor (density)	**CI_L Larvae HSI =$(V_1 X V_2 X V_3)^{1/3}$ if V_3=0 $(V_1{}^X V_2)^{1/2}$**	V4 Hist Mean Sal Index calculated by	V5 Mean-Kill Freq Index(Tt V_1)	V6 Substrate Firmness*	**CI_A =$(V_4 X V_5 X V_6)^{1/3}$ if V_6 =0 CI_A= 0**	**Oyster HSI If CI_A is<CI_L HSI=CI_A, if CI_A<CI_L HSI =$(CI_A X CI_L)^{1/2}$**
Existing Condition	0.0	1.0	0.0	*0.0*	1.0	1.0	0.0	*1.0*	**0.0**
Future With Reef Construction	1.0	1.0	1.0	*1.0*	1.0	1.0	1.0	*1.0*	**1.0**
Future Without	0.0	1.0	0.0	*0.0*	1.0	1.0	0.0	*1.0*	**0.0**

Notes:* existing and future without condition >80% sand =0

Construction of new sanctuary reefs would add suitable cultch (V1); provide a firm rock layer where bare sandy bottom currently exists (V6). Variable V3, oyster density, will be assumed to be equal to nearby reference reefs by year 3. Benefits realized by construction of new sanctuary reefs will not be fully realized until year 3 at which time oyster recruitment and growth is expected to equal that of natural reefs located in the same cell. Habitat data for reference reefs are shown in Reference 3. FIs were annualized as shown in Reference 4. For simplicity, benefits are assumed to increase linearly until year 3.

Benthic Conditions Evaluated. Two potential bottom conditions were evaluated to determine suitability for oyster growth including (1) oyster reef (with project condition) and (2) sandy bottoms in the vicinity < 50M of new reef structure (with project condition). Future without project conditions over the 50 year period of analysis is status quo, where unprotected sandy bottom would persist. Under with project conditions sandy bottoms would be converted to functioning reefs with HSI equal to 1.0 or reef service area HSI =0.5 after a 3 establishment period.

Oyster Reefs. HSI for reef habitat in the proposed reef construction area would be 1.0, indicating ideal condition for oyster establishment and growth. These sites would have a hard structure that elevates the reef tops reducing potential exposure to hypoxia and

would be protected from harvest. The benefits of reef habitat are well documented (Deaton et al. 2010, Posey et al. 1999, Mann 2001, Peterson et al. 2003, Soniat et al. 2004) as summarized below. The structural relief provided by high profile reefs and associated current upwelling would attract pelagic forage fish, and a shell covered surface provides habitat for resident species such as crabs, gobies, blennies and toad fish. These food resources would support transient fish such as bluefish and Spanish mackerel, anadromous fish, including striped bass, and important estuarine spawning sport fish, like red drum, would also use these food resources as they congregate in preparation for spawning. Juvenile sea bass, grouper and other ocean spawning estuarine dependent species, would also use these reefs as essential habitat during their exodus from estuarine nursery areas to the ocean. Abundant oysters support improved water quality by providing substantial filtering (Cresman et.al 2003), and provide improved habitat conditions supporting higher fish and fish food production. As an established oyster sanctuary, the reef and associated fauna would be protected from commercial harvest and bottom disturbance.

Sandy Bottoms Adjacent to Reefs. Once reefs are established adjacent estuarine bottoms within 50M of the reefs were determined to have an average HSI of 0.5. Studies have shown that significant increases in the numbers of fish and species richness would occur over adjacent bottom areas extending 50 - 100 meters away from the reef (dos Santos et al. 2010). As an established oyster sanctuary, the reef service area, bottom habitats and resident fauna, would be protected from commercial harvest and bottom disturbance.

Habitat Output. Two alternative designs and multiple size configurations were evaluated as listed below. Various reef designs and configurations alter the area of clutched or rock surface available for oyster attachment and the area of adjacent estuarine bottom that is enhanced by the reef proximity. The designs that maximize the reef and service area generate the most benefits. HUs and project costs were calculated for No Action and 2 containment scenarios, and 8 size combinations as shown below:

(1) No Action (**Alt 1**)
(2) Stone Containment:
- **Alt 10: One 18.60 Acre Reef**
- **Alt 11: One 15.06 Acre Reef**
- **Alt 12: One 9.70 Acre Reef**
- **Alt 13: Two 9.70 Acre Reef Complex**
- **Alt 14: One 5.07 Acre Reef**
- **Alt 15: Two 5.07 Acre Reef Complex**
- **Alt 16: Three 5.07 Acre Reef Complex**
- **Alt 17: Four 5.07 Acre Reef Complex**

(3) Sheetpile Containment:
- **Alt 2: One 18.60 Acre Reef**
- **Alt 3: One 15.06 Acre Reef**
- **Alt 4: Once 9.70 Acre Reef**
- **Alt 5: Two 9.70 Acre Reef Complex**

Alt 6: One 5.07 Acre Reef
Alt 7: Two 5.07 Acre Reef Complex
Alt 8: Three 5.07 Acre Reef Complex
Alt 9: Four 5.07 Acre Reef Complex

Table 5.09. *Oyster Areas and Outputs for Various Alternatives.*

ALTERNATIVES	OYSTER REEF		SERVICE AREA		OUTPUT	
	HAB INDEX	ACRES	HAB INDEX	ACRES	HUs	AAHUs
Alt 1	0.0	0.0	0.0	0.0	0.0	0.0
Alt 2	1.0	19.86	0.5	16.47	28.1	27.3
Alt 3	1.0	16.20	0.5	15.12	23.8	23.0
Alt 4	1.0	9.70	0.5	13.63	16.5	16.0
Alt 5	1.0	19.40	0.5	27.26	33.0	32.0
Alt 6	1.0	6.00	0.5	9.70	10.9	10.5
Alt 7	1.0	11.48	0.5	19.92	21.4	20.8
Alt 8	1.0	17.21	0.5	29.89	32.2	31.2
Alt 9	1.0	22.95	0.5	39.85	42.9	41.6
Alt 10	1.0	20.38	0.5	16.65	28.7	27.8
Alt 11	1.0	16.66	0.5	15.25	24.3	23.6
Alt 12	1.0	10.99	0.5	12.89	17.4	16.9
Alt 13	1.0	21.99	0.5	25.77	34.9	33.8
Alt 14	1.0	6.02	0.5	10.18	11.1	10.8
Alt 15	1.0	12.03	0.5	20.37	22.2	21.6
Alt 16	1.0	18.05	0.5	30.55	33.3	32.3
Alt 17	1.0	24.07	0.5	40.73	44.4	43.1

Note: (Reef Hab Index ***x*** Acres) **+** (Service Area Hab Index ***x*** Acres) = HUs

For each alternative, an Average Annual Habitat Unit (AAHU) was calculated (Table 5.09). AAHU are calculated by determining Habitat Units for each project year, adding these together, and dividing by the project life (50 years). The total AAHU *benefit* for oysters is the difference between the AAHU calculated for that alternative (with project) and the AAHU calculated for the no action alternative (without project). In all the alternatives evaluated, the without project condition was 0.

5.4.4 Cost Effectiveness/Incremental Cost Analysis

For ecosystem restoration planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, cost effectiveness analyses offer plan evaluation approaches that are consistent with the P&G paradigm. Cost effectiveness analyses are conducted to ensure that the least cost plans are identified for each possible level of ecosystem restoration output; and that for any level of investment, the maximum level of output is identified.

In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of ecosystem restoration plans, cost effectiveness analyses are valuable tools to assist in decision-making. The results of the analyses permit decision-makers to progressively compare alternative levels of ecosystem restoration outputs.

Methodology. Data for initial construction/implementation, land acquisition, monitoring, and periodically recurring costs for OMRR&R (operation, maintenance, repair, replacement, and rehabilitation), have been developed through engineering design and cost estimation, and real estate appraisal efforts. Details of that data development are explained and discussed elsewhere in this report. The main issues requiring economic evaluation attention include present worth calculations, price levels, and timing of project spending.

Costs represent the difference between conditions without any plan (the “base condition”, or “without-project condition”) and with a plan or alternative. For purposes of this report and analysis, NER costs (National Environmental Restoration Costs, as defined by Federal and Corps of Engineers policy), are expressed in 2012 price levels, and are based generally on costs estimated to be incurred over a 50 year period of analysis. Costs of a plan represent the value of goods and services required to implement and operate/maintain the plan.

The timing of a plan’s costs is important. Construction and other initial implementation costs cannot simply be added to periodically recurring costs for project operation, maintenance, and monitoring. Also, construction costs incurred in a given year of the project can’t simply be added to construction costs incurred in other years if meaningful and direct comparisons of the costs of the different alternatives are to be made. A common practice of equating sums of money across time with their equivalent at an earlier single point in time is the process known as discounting. Through this mathematical process, which involves the use of an interest rate (or discount rate) officially prescribed by Federal policy for use in water resource planning analysis (currently set at 4.0% per year), the cost time streams of each alternative are mathematically translated into a present worth value. This present worth value, calculated for this study as of the beginning of the period of analysis, can then be directly and meaningfully compared between the plans being considered in this study.

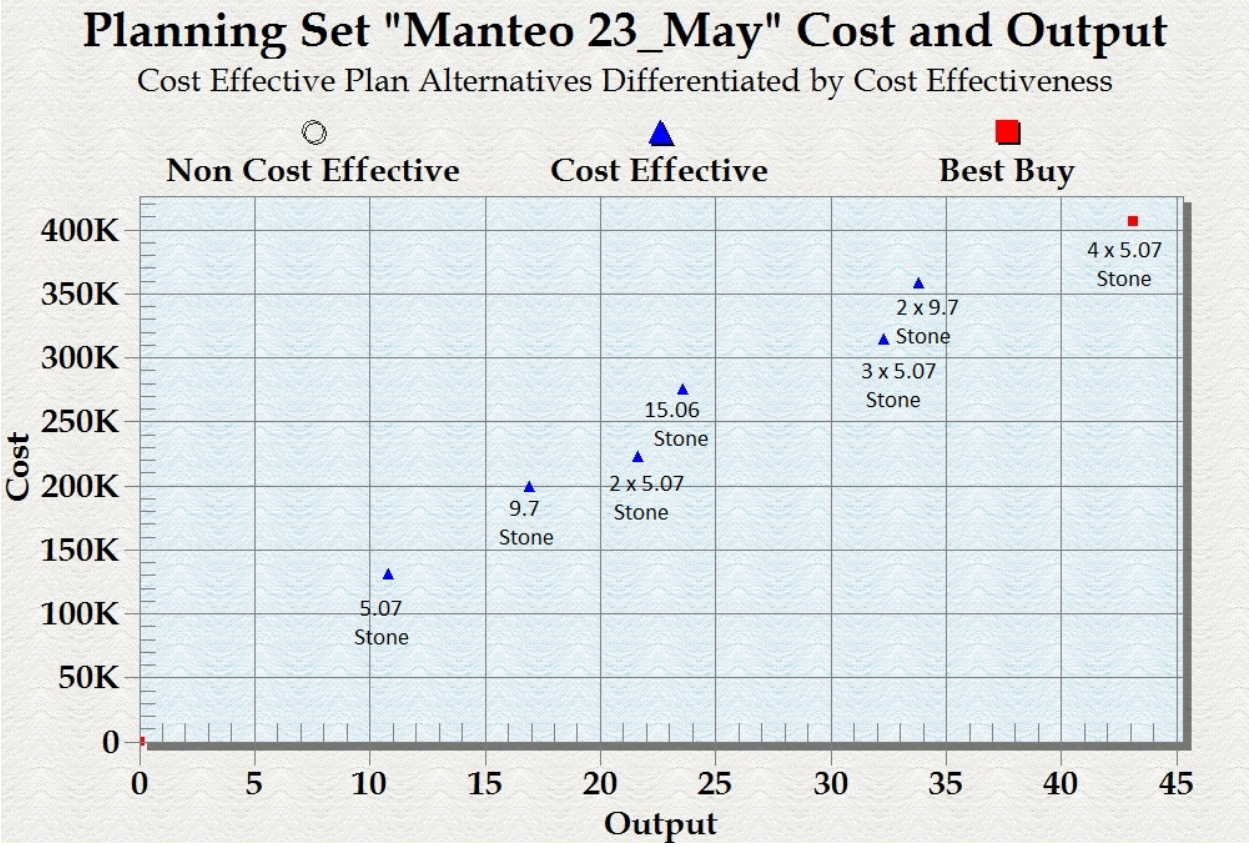
An annual value, equivalent to the present worth, can also be computed for the 50 year period of analysis. This average annual value represents an equivalent way of expressing the costs of a plan. The various costs estimated to be incurred over time to put each plan into place and keep it going will be computed and expressed as both a present worth value and an average annual equivalent value.

Cost Effective Alternative Selection. Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of output considered. The resulting least cost alternative plans are then compared to identify those that would produce greater levels of output at the same cost, or at a lesser cost, as other alternative plans. Alternative plans identified through this comparison are the cost effective alternative plans. Next, the cost effective alternative plans are compared to identify the most economically efficient alternative plans, that is, the “Best Buy” alternative plans that would produce the largest output for the associated cost. Finally, the additional costs for the additional amounts of output (“incremental cost”) produced by the Best Buy alternative plans are calculated. The results of all the calculations and comparisons of costs and outputs provide a basis for addressing the decision question of if the additional outputs worth the costs incurred to achieve them.

Table 5.10. *Cost and Performance Summary for Plan Selection (in order of ascending habitat output)*

	COST AND PERFORMANCE SUMMARY USED IN COST EFFECTIVENESS FOR PLAN SELECTION, Manteo 204							
Alternative # and Description		**Estimated Cost**	**Average Annual Cost**	**Average Annual Habitat Units**	**Cost Per Habitat Unit**	**Cost Effective ?**	**Best Buy?**	**Cost Within CAP limit?**
1	No Action		$0.00	0.0	$0	Yes	Yes	Yes
6	Sheet Pile 5.07	$4,304,592	$208,395	10.5	$19,847	No	No	Yes
14	Stone 5.07	$3,024,840	$146,439	10.8	$13,559	Yes	No	Yes
4	Sheet Pile 9.7	$6,202,513	$300,277	16	$18,767	No	No	Yes
12	Stone 9.7	$4,425,449	$214,146	16.9	$12,677	Yes	No	Yes
7	Sheet Pile 2X5.07	$7,473,198	$361,794	20.8	$17,394	No	No	No
13	Stone 2X5.07	$4,916,793	$238,033	21.6	$11,020	Yes	No	Yes
3	Sheet Pile 15.06	$8,221,938	$398,042	23	$17,306	No	No	No
11	Stone 15.06	$5,999,991	$290,473	23.6	$12,308	Yes	No	Yes
2	Sheet Pile 18.6	$9,492,913	$459,573	27.3	$16,834	No	No	No
10	Stone 18.6	$7,024,596	$340,076	27.8	$12,233	No	No	Yes
8	Sheet Pile 3X5.07	$10,641,804	$515,193	31.2	$16,513	Yes	No	No
5	Sheet Pile 2X9.7	$11,286,353	$545,526	32	$17,047	No	No	No
16	Stone 3X5.07	$6,804,659	$329,429	32.3	$10,199	Yes	No	Yes
13	Stone 2X9.7	$7,718,010	$373,646	33.8	$11,055	Yes	No	No
9	Sheet Pile 4X5.07	$13,810,410	$668,192	41.6	$16,062	No	No	No
17	Stone 4X5.07	$8,695,469	$420,967	43.1	$9,767	Yes	Yes	No

Figure 5.04. *Planning Set Cost and Output*

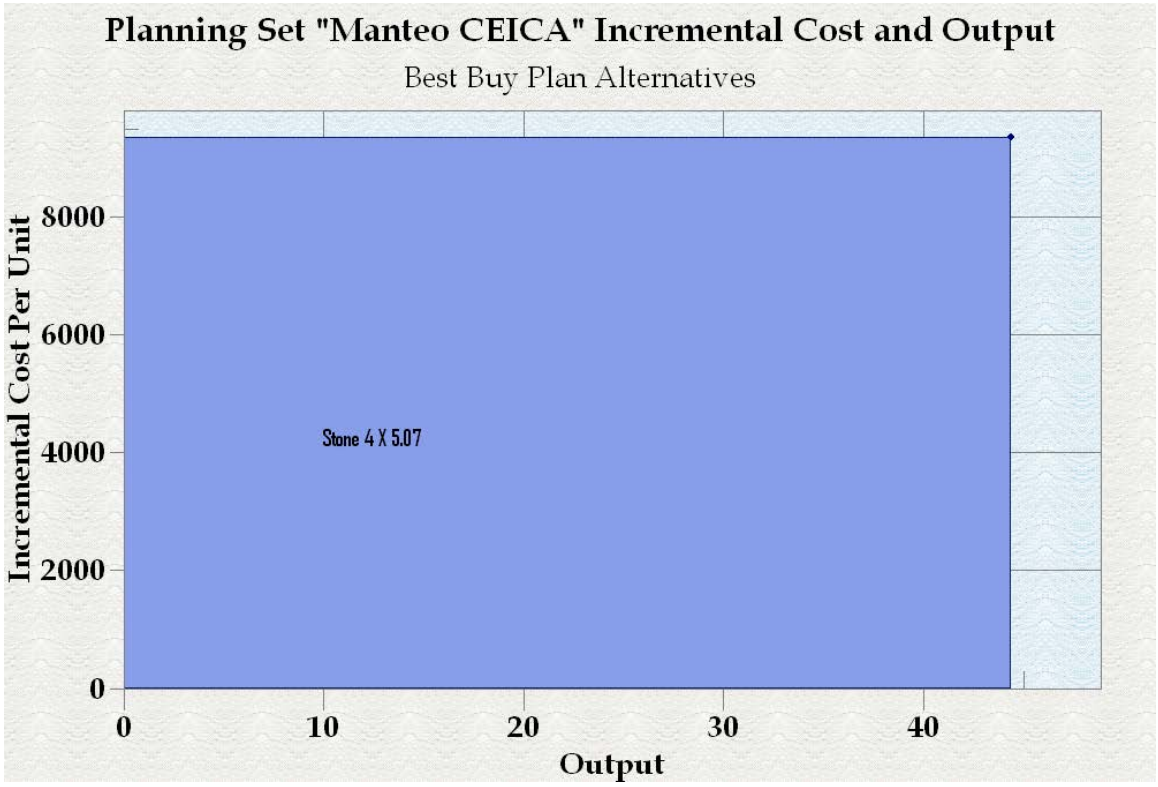


Incremental Cost Analysis. This section presents the results of incremental cost analysis for the Manteo 204 alternative plans for the optimization of the site. All the cost effective plans are arrayed by increasing output to clearly show changes in cost (i.e., increments of cost) and changes in output (i.e., increments of output) of each cost effective alternative plan compared to the Without Plan condition. The plan with the lowest incremental costs per unit of output of all plans is the first Best Buy plan. After the first Best Buy plan is identified, all larger cost effective plans are compared to the first Best Buy plan in terms of increases in (increments of) cost and increases in (increments of) output.

Table 5.11. *Results of Incremental Cost Analysis*

RESULTS OF INCREMENTAL COST ANALYSIS: BEST BUY PLANS ARRAYED BY INCREASING OUTPUT FOR COMBINED HABITAT (ALL PLANS)						
Plan	Average Annual Cost	Output	Average Cost Per Output	Incremental Average Annual Cost	Incremental Output	Incremental Cost Per Output
No Action	$0	0	$0	$0	0	$0
Stone 4X5.07	$420,967	43.1	$9,767	$420,967	43.1	$9,767

Figure 5.05. *Planning Set Incremental Cost and Output*



5.5 Screening of Alternative Plans

The alternatives considered in this analysis were screened based on a number of factors, all of which are discussed below.

Completeness, Effectiveness, Efficiency, and Acceptability. Completeness, Effectiveness, Efficiency, and Acceptability are the four evaluation criteria specified that the USACE uses in the screening of alternative plans (USACE P&G Section 1.6.2(c)). Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans.

Completeness. A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, operations and maintenance, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain restoration features and an adaptive management plan has been proposed, it must be considered for in the plan.

Of the alternatives considered in detailed analysis, all directly address the identified problem of the decline of oyster habitat in Pamlico Sound. Those alternatives consisting of larger acreages of restored area would provide greater benefit. Successful resource reference areas in the project vicinity add assurance that the benefits attributed to these alternatives in this analysis will actually be realized. For this study, an adaptive management plan is described in Section 6.3.

Effectiveness. Effectiveness is the extent to which an ecosystem restoration plan alleviates the specified problems and achieves the specified opportunities. The cost-effectiveness of the array of alternatives was analyzed using IWR-Plan software. Alternatives 11, 12, 13, 14, 15, 16, and the No-Action plan were identified as being effective in terms of cost per benefit.

Efficiency. Efficiency is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities. The problem identified and opportunities that may be realized under this Section 204 study are associated with the future without project condition of lack of oyster habitat in the project vicinity, and an opportunity to contribute to the connectivity of a self-sustaining network of oyster reefs in Pamlico Sound, NC as expressed by the North Carolina Oyster Restoration Steering Committee's northern workgroup. As discussed in Section 5.4.4, Alternative 17 and the no-action plan were designated as Best Buy alternatives. As a result, these are the alternatives that provide the most "bang for the buck", and therefore are the most efficient alternatives. However, the no-action does not address the identified problem or opportunities that exist. Additionally, Alternative 17 exceeds the federal cost-share limit of the Section 204 authority.

Therefore, the most cost-efficient alternative identified by IWR-Plan that is within the cost constraints of the authority was identified as Alternative 16.

Acceptability. An ecosystem restoration plan should be acceptable to state and Federal resource agencies, local governments and the public, and compatibility with existing laws, regulations, and public policies. A recommended plan must be acceptable to the non-Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan. All of the alternatives under consideration are in concert with state and Federal agency views in that oyster habitat in Pamlico Sound should be addressed in order to restore and preserve the ecological integrity of the Albemarle-Pamlico National Estuary system of North Carolina. A recommended plan should also fall within the cost limitation of the Section 204 Authority. The best buy plan, Alternative 17, exceeds the cost limitations. Alternatives 11, 12, 13, 14, 15, 16, and the No-Action plan were identified as being effective in terms of cost per benefit and were within cost limitations of the Authority.

5.6 Resource Significance

This section provides a qualitative evaluation and summary of the alternative impacts to significant resources. Along with information from cost effectiveness and incremental costs analyses, information on the significance of ecosystem outputs will help determine whether a proposed environmental investment is worth the cost. The significance of the Manteo, Old House Channel, NC restoration outputs is herein recognized in three categories: *Institutional, Public*, and/or *Technical*.

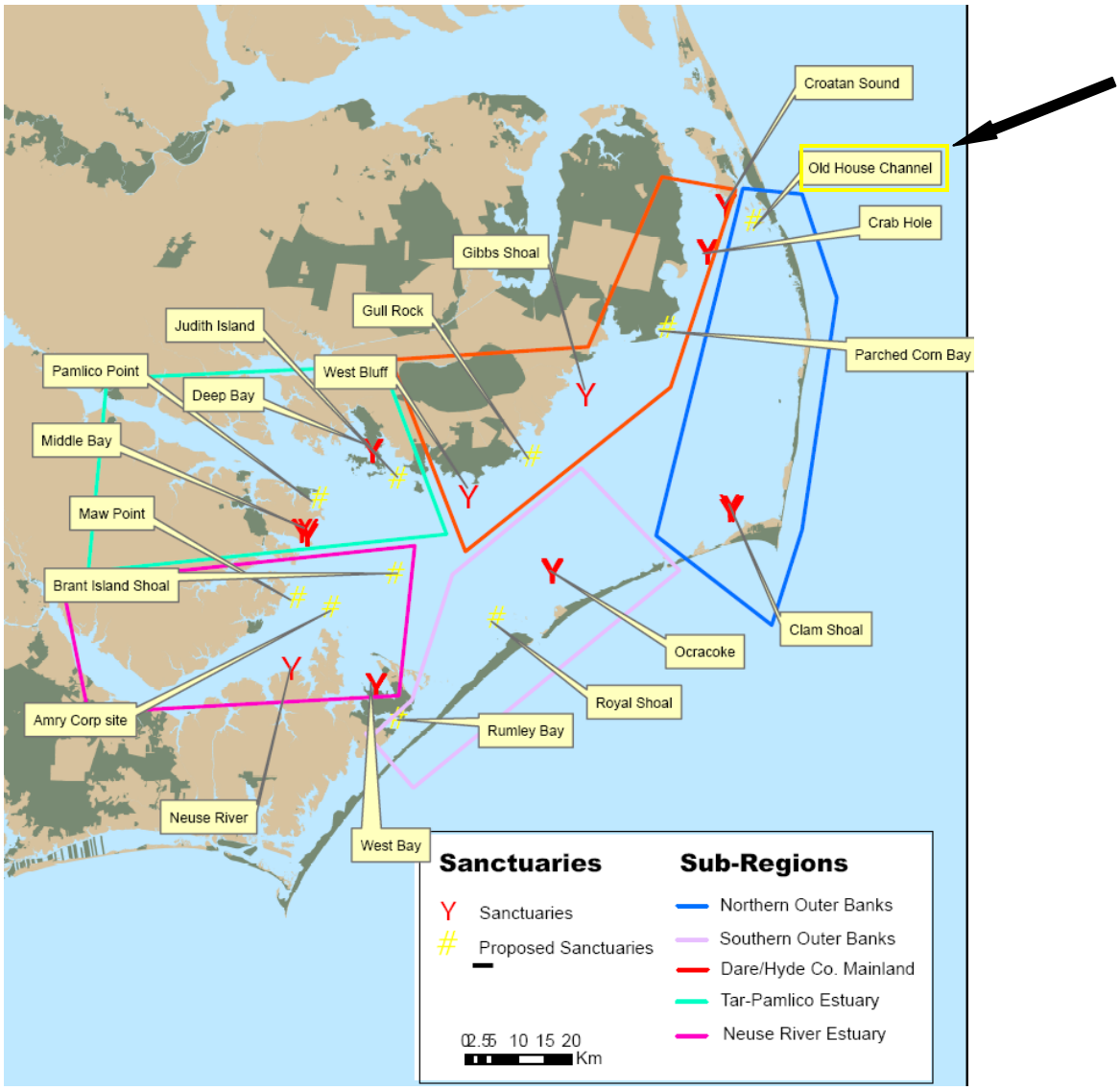
5.6.1 Institutional Significance.

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; charters, bylaws, and other policy statements of private groups.

The Albemarle-Pamlico Sound was designated by Congress as an “estuary of national significance” in 1987. Oysters have been recognized as a keystone species of that ecosystem (Street et al. 2005; Peterson et al. 2003; NCDMF 2009). The North Carolina Division of Marine Fisheries (NCDMF) has designated the Eastern Oyster (*Crassostrea virginica*) as a species of “Concern” due to long term decline caused by overharvesting and habitat disturbances (NCDMF 2010). Oyster restoration is a high priority for the State of North Carolina as expressed in the Blue Ribbon Report (Frankenburg 1995). Restoration of oysters in North Carolina is also a national goal of the US EPA’s Albemarle-Pamlico Sound National Estuary Program

(source:www.carteret.edu/aqu/cogp/). The NC Oyster Restoration Steering Committee (NCORSC), comprised of various resource agencies and private organizations, has identified the project vicinity as a priority area for restoration as part of an overall plan to create a self-sustaining network of oyster reefs in Pamlico Sound (Figure 5.06. Source: Notes from NE Oyster Work Group Meeting March 18, 2010). The NCORSC Northern Work Group also has a stated goal of "*500 acres of new reef constructed and designated as sanctuaries by 2018*". The agencies and organizations that comprise the NCORSC include the NC Division of Coastal Management, The NC Division of Marine Fisheries, the NC Division of Water Quality, the NC Department of the Environment of Natural Resources, The NC Division of Environmental Health – Shellfish Sanitation Section, US Army Corps of Engineers, the North Carolina Coastal Federation, The Nature Conservancy, North Carolina Sea Grant Program, UNC Wilmington, NC State University, and UNC Chapel Hill Institute of Marine Sciences (NCCF, 2008). All of the alternatives in the final array under consideration work in concert with local, state, and Federal goals of oyster restoration in North Carolina.

Figure 5.06. Priority Areas for Oyster Restoration, as recommended by the NCORSC Northern Workgroup (Includes Old House Channel). Source: North Carolina Oyster Work Group meeting notes, March 18, 2010.



5.6.2 Public Significance.

Significance based on public recognition means that some segment of the general public recognized the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Organized public volunteer efforts are routinely underway throughout each year in North Carolina to restore oysters to North Carolina's waters, both by recycling oyster shells for replacement in the water, and by support and membership in private organizations such as the North Carolina Coastal Federation which engage in active programs to restore the oyster population in North Carolina (NCCF, 2011).

Figure 5.07. *Volunteers Placing Oyster Shells in NC Waters to Create Reef. (source: NCCF)*

5.6.3 Technical Significance.

Significance based on technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Technical significance should be described in terms of one or more of the following criteria: scarcity, representation, status and trends, connectivity, and limiting habitat.

Significance of oysters as an important resource has been widely recognized and documented.

General. Oysters are good indicators of the overall health of an estuarine ecosystem (NCCF, 2008). They improve water quality and provide essential fish habitat and are a source of food for associated aquatic life. The irregular surfaces of oyster reefs provide fifty times the surface area of a similarly extensive flat bottom. Unique crevices provide good nursery habitat for a wide diversity of vertebrate and invertebrate organisms such as worms, snails, sea squirts, sponges, small crabs, and fishes. The small inhabitants of the subtidal reef community are the base of the food chain for a wide variety of predators. Oyster reefs are recognized by fisheries management agencies as vital habitat for certain commercially and recreationally important fish species and critical to

fisheries production (Street, 2005). A recent study, conducted through the North Carolina Sea Grant on the use of oyster reef habitat by economically valuable species, suggests that restoring oyster reef habitat enhances fish production and potential harvest levels in North Carolina estuaries (Peterson and Grabowski, 2003). In addition, the presence of oyster reef sanctuaries provides a brooding stock which benefits the robustness of harvestable oyster reefs in adjacent waters (NCDMF, 2008 and Street et al., 2005).

Scarcity. Researchers estimate that 85% of oyster reefs world-wide have been lost (AFP 2011). In North Carolina, the eastern oyster has been given the stock status of *Concern* due to overharvesting and dredging practices (NCDMF 2010). Oyster landings in North Carolina are estimated to be only ten percent of what they were just over a century ago (Ortega & Sutherland, 1992; Street et al. 2005). All alternatives would contribute positively to reducing the scarcity of this resource.

Status and trends. Since the early 1900's, North Carolina's oyster harvests have declined 90 percent, with current estimates that only 50 percent of the population remains from the late 1800's. With recognition of the importance of the oyster as a keystone species in ecosystem health, local, state and federal efforts have increased to restore oyster reef habitat. The NC Oyster Sanctuary Program has helped to increase biomass of oysters in and around the Pamlico Sound area (NCDMF 2010). Restoration is viewed as an essential tool to sustain long-term management of North Carolina's oyster population. All alternatives would contribute to varying degrees in increasing the biomass of oysters in northern Pamlico Sound.

Connectivity. The NCORSC Northern workgroup has a goal of developing a network of self-sustaining oyster reefs in Albemarle-Pamlico National Estuary as described by the NCORSC's Oyster Restoration and Protection Plan. Through modeling, historic data and knowledge of the area, NCORSC has identified the project vicinity as an area of need for re-establishment of oysters as part of an overall plan to create a self-sustaining network of oyster reefs in Pamlico Sound (Figure 5.06 Source: Notes from NE Oyster Work Group Meeting March 18, 2010). All alternatives would contribute to this network. Also, as a keystone species, oysters provide habitat to a wide variety of sea life.

5.7 The Ecosystem Restoration Plan

The criteria used to select the NER plan include all the evaluation criteria discussed above. Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, completeness, effectiveness, efficiency, and acceptability. Additional factors to consider include the following items:

5.7.1 Partnership Context

This Beneficial Use of Dredged Material project was planned in cooperation with the State of North Carolina. The North Carolina Coastal Federation and the NC Oyster Restoration Steering Committee's northern workgroup also provided valuable input. This project planning process included an opportunity for open comment to ensure the public has had opportunities to contribute.

5.7.2 Reasonableness of Costs

All costs associated with a plan were considered, and tests of cost effectiveness and incremental cost analysis have been satisfied for the alternatives analyzed. Cost estimates were based on the costs of transportation of construction materials to the site as well as project construction, and included contingency costs of 19%.

5.8 Plan Selection

5.8.1 The NER/Preferred Plan

The plan that reasonably maximizes net national ecosystem restoration benefits and is consistent with the Federal objective is identified as the NER plan. As mentioned in section 5.4.4, cost effectiveness/incremental cost analysis identified alternative 17 (stone sill, 4x5.07 acres) and the no-action plan as the best buy plans. Alternative 16 (stone sill, 3x5.07 acres) was also identified as the most cost-efficient alternative that is within the cost constraints of the Section 204 authority. Since the no-action plan does not meet study objectives, and alternatives 16 and 17 both provide significant ecosystem restoration benefits in a cost-effective manner, the no-action plan was removed from consideration as the NER plan. As indicated in table 5.10, the incremental cost of implementing Alternative 17 is $9,767 per habitat unit. This is slightly less than the incremental cost of $10,199 per habitat unit for Alternative 16. The next most cost-effective plan is Alternative 11 with an incremental cost of $12,308 per habitat unit. Alternative 16 is the plan with the lowest cost per unit of habitat ($10,199) that is within the cost constraints of the Section 204 Authority. Therefore, **Alternative 16 is selected as the NER plan and the federally recommended plan**.

5.8.2 NED/Optimum Tradeoff Plan

Because all alternatives considered address ecosystem restoration of the Old House Channel area rather than national economic development, no plans have been identified as being the NED plan. Additionally, there is no optimum trade off plan as each of the alternatives considered only address ecosystem restoration.

5.8.3 Locally Preferred Plan

There is no locally preferred plan. The sponsor fully supports the NER plan. The NER plan will best meet the sponsor's goals of restoring oyster habitat in Pamlico Sound in conjunction with dredging operations at Old House Channel.

5.8.4 Designation of the Tentatively-Selected Plan

Alternative 16 is designated as the tentatively-selected plan due to the fact that it is both the NER plan as well as the locally preferred plan. Within the cost constraints of the Section 204 Authority, this plan will provide the greatest ecosystem restoration benefits in the most cost effective manner and is also the plan most desirable to the local sponsor while having minimal adverse environmental impacts. This plan will advance the goals of North Carolina's oyster restoration efforts, including the NCORSC's stated goal of 500 acres of new oyster reef constructed and designated as sanctuary by 2018. Restoration of oysters in North Carolina is also a national goal of the US EPA's Albemarle-Pamlico Sound National Estuary Program. Lastly, it will alleviate the volume of dredged material placed on existing disposal islands during the associated dredging cycle, an objective supported by the NCWRC.

6.0 TENTATIVELY-SELECTED PLAN

6.1 Plan Description

The Tentatively-Selected Plan (TSP), having best met the alternative screening conditions in comparison to all other alternatives, is designated as the Recommended Plan. Under the TSP, three submerged oyster reefs would be constructed within close proximity of each other, approximately 1.7 miles from Old House Channel (Range 2). Stone sills made of NCDOT Class 2 armor stone (9"-23") would be constructed to create three 5.07 acre containment areas for dredged material. The three 5.07 acre containment areas would contain a total of approximately 135,000 cubic yards of dredged material. The three separate containment areas would be constructed in close proximity of each other with spacing of approximately 100 yards. The core portion of the containment structures would be constructed of NCDOT Class B Stone (5"-12"). Reefs would be constructed during a regularly scheduled maintenance dredging cycle for the navigation channels. Dredged material from maintenance dredging of the federal navigation channel would be pumped into the containment areas and would, most likely, utilize a hydraulic pipeline dredge. However, other dredges could be used. The dredged material would be covered with NCDOT Class A stone and oyster shell to provide habitat for establishment of oysters. A typical cross section is shown in Figure 5.03. Approximately 18 acres of new oyster reef habitat would be created, as well as enhanced service area associated with the reefs. The construction of the preferred oyster reef alternative would be a one-time event under the Section 204 Authority.

However, this project could serve as a pilot for future oyster restoration efforts in conjunction with dredging operations.

6.2 Real Estate Requirements

The tentatively selected plan for the project consists of three 5.07 acre submerged oyster reefs within close proximity of one another (100 yards between one reef edge and another). Submerged stone containment rings will be constructed, and then filled with dredged material from maintenance dredging of Old House Channel. The sand-based reefs will then be topped with cultch for oyster reefs. The location of the reef configuration will be where good oyster growing conditions are found near the navigation channel and where submerged aquatic vegetation (SAV) or other significant resources do not immediately exist. The project study area is shown in Figures 2.01 and 2.02. All reef development and construction will be accomplished below mean high water (MHW). These areas are considered lands of the State and a permit will be required from the State of North Carolina Department of Administration State Property Office for construction of the project in state waters.

As this project will make beneficial use of dredged material, no borrow site is required. The only real estate requirement identified is a staging area of approximately 0.5 of an acre that will be needed for an estimated period of 6-12 months. Two parcels as shown in Figures 6.0.1 and 6.0.2 are owned by the State of North Carolina and could be made available for staging areas. Only one parcel would be needed. Acquisition of a Temporary Work Area Easement for the staging area could be accomplished within 6 months.

Figure 6.01. *Potential Staging Area Dare County*

Figure 6.02. *Potential Staging Area Hyde County*

The Temporary Work Area Easement. A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____), for a period not to exceed 12 months, beginning with date possession of the land is granted to the Sponsor for use by the Sponsor, its representatives, agents, and contractors as a work area, including the right to move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Manteo, Old House Channel, NC Section 204 Project, together with the right to trim, cut, fell and remove there from all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

The proposed project would offer environmental improvements by creating new oyster reefs. No adverse environmental impacts are expected. No hazardous, toxic and radioactive wastes have been identified in the project area. There are no utility/facility relocations required for implementation of the project, and there are no relocations of individuals under PL 91-646. The project is not for commerce related purposes and has no nexus to navigation; therefore Navigation Servitude does not apply. There is no known public opposition to the project.

The State of North Carolina is the non-Federal sponsor for the project (NFS). The NFS has the responsibility to acquire all real estate interests required for the Project. The NFS shall accomplish all alterations and relocations of facilities, structures and improvements determined by the government to be necessary for construction of the Project. The sponsor will have operation and maintenance responsibility for the project after construction is completed.

Title to any acquired real estate will be retained by the Project Sponsor and will not be conveyed to the United States Government. Prior to advertisement of any construction contract, the NFS shall furnish to the government an Authorization for Entry for Construction to all lands, easements and rights-of-way, as necessary. The NFS will also furnish to the government evidence supporting their legal authority to grant rights-of-way to such lands. The NFS shall comply with applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, and amended by Title IV of the Surface Transportation Uniform Relocation Assistance Act of 1987, Public Law 100-17, effective 2 April 1989, in acquiring real estate interests for the Project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act(s). The non-Federal sponsor is entitled to receive credit against its share of project costs for the value of lands it provides and the value of the relocations that are required for the project. Generally, for the purpose of determining the amount of credit to be afforded, the value of the lands, easements and rights-of-way (LER) is the fair market value of the real property interest, plus certain incidental costs of acquiring those interests, that the non-federal sponsor provided for the project as required by the

Government. The NFS will not receive credit for lands used that were previously provided as an item of cooperation.

The NFS should not acquire lands required for the project prior to execution of the Project Partnership Agreement (PPA). Should the NFS proceed with acquisition of lands prior to execution of the PPA, it is at the risk of not receiving credit or reimbursement for any costs incurred in the connection with the acquisition process should the PPA not be signed. There is also risk in acquiring lands either not needed for the project or not acquired in compliance with requirements for crediting purposes in accordance with 49 CFR Part 24, dated March 2, 1989. A Realty Specialist will meet with the NFS prior to construction to discuss the real estate acquisition process and to provide guidance.

The estimated real estate costs include the land cost for acquisition of land and federal and non-federal administrative costs. Land cost is based on an opinion of value dated April 5, 2011 and on a market rental rate of 10% for one year. Administrative costs are those costs incurred for verifying ownership of lands, certification of those lands required for project purposes, legal opinions, analysis or other requirements that may be necessary during Design and Implementation (D&I). A 25% contingency is applied to the estimated total for these items. Table 6.01 is a summary of the real estate cost for the project.

Table 6.01. *Real Estate Cost Estimate*

Manteo Section 204 Real Estate Cost Estimate

		Federal	Non-Federal	Total
01B	LANDS AND DAMAGES			
01B40	Acq/Review of NFS	$ 5,000	$	$ 5,000
01B20	Acquisition by NFS	$	$ 20,000	$ 20,000
01BX	Contingencies (25%)	$ 1,250	$ 5,000	$ 6,250
	Subtotal	$ 6,250	$ 25,000	$ 31,250
01G	Temporary Permits/Lic/ROEs			
01G20	By NFS	$	$ 5,000	$ 5,000
01GX	Contingencies (25%)	$	$ 1,250	$ 1,250
	Subtotal	$	$ 6,250	$ 6,250
01R	REAL ESTATE LAND PAYMENTS			
01R1B	Land Payments by NFS	$	$ 5,500	$ 5,500
01RX	Contingencies (25%)		$ 1,375	$ 1,375
	Subtotal	$	$ 6,875	$ 6,875
	TOTALS	$ 6,250	$ 38,125	$ 44,375
	ROUNDED TO			$ 44,500

6.3 Monitoring and Adaptive Management Plan

Monitoring

In accordance with Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007), feasibility studies for ecosystem restoration are required to include a plan for monitoring the success of the ecosystem restoration. "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be need to attain project benefits." Therefore, Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecosystem restoration projects.

The goal of monitoring for the project is to measure whether the project objectives have been met or not. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance. Pre-construction, during-construction and post-construction monitoring shall be conducted by the Corps and cost shared with the local sponsor. Cost-shared post construction monitoring is allowed for up to 10 years. For this project, a 5-year habitat establishment/persistence period is expected, and therefore monitoring should be concluded in 5 years. However, if after year 5, success cannot be determined, monitoring would continue and be the responsibility of the local sponsor.

Structural Persistence. A Hydrographic survey of the reef site identifying significant project features will be made upon completion (year 1) as a construction cost. This survey will document base conditions and construction compliance. A comparison monitoring survey will be made at the end of the monitoring period (Year 5) to determine structural persistence of project components. The areal extent of the reef will be mapped and quantified. Visual documentation of site conditions by underwater camera sled will be conducted concurrent with the survey operation if water conditions permit.

> **Success Criteria**. The Manteo 204 Reef Sanctuaries will be considered successful if at the end of 5 years the site is documented to be in a generally stable condition.

Biological Persistence. Biological sampling would be conducted annually for 5 years following construction. Monitoring would be extended to 10 years, if needed. Monitoring would include collection of reef stones and/or Quadrate Samples by Divers to assess colonization by oysters and other fowling organisms. Three (3) randomly selected target areas would be evaluated by collection and analysis of 3 samples each, on an annual basis in years 1- 5. Methods will be consistent with NCDMF sanctuary sampling methods, as outlines below, to the degree practical. The information obtained will be compared to the previous year's sampling results from the restoration site and annual state sanctuary Indexes as available. Faunal utilization of the site will be

assessed by qualitative methods. An annual monitoring report will be prepared and coordinated with interested parties.

The following information will be collected for each sample per the NCDMF sanctuary sampling methods:

- Length x Width x Height of rock (mm)
- Number of live and dead oysters
  - 3 size classes spat, sublegal and legal size oysters
- Height of each alive and dead (box) oyster. (Size distribution)
- Organisms found attached to rock and extent (fouling)
  - Barnacles, mussels, tunicates, bryozoans, sponges, limpets, etc.
  - Recorded as percent coverage using 7 graded scale which recognizes only seven possible coverage percentages; 1, 5, 10, 25, 50, 75, and 100percent
- Presence and number of predators
  - Oyster drills, crabs, etc.

Success Criteria. Manteo 204 Sanctuary will be considered successful if at Year 5, the oyster density is at least 25 oysters/$m^{2.}$ (Combined all size classes) for 3 of the 5 years sampled.

Monitoring Cost

Events	Cost per Event	No. of Events	Total Cost
Survey Contract	$30,000	**1**	$30,000
Biological Contract	15,944	**5**	79,720
Corps Support	10,000	**6**	60,000
Corp Dive inspector	5,000	**5**	25,000
Total			**194,720**

Total Cost Estimate **$200,000***

* monitoring costs included as part of Total Project Costs and are cost shared on a 65% Federal/ 35% Non-Federal basis.

Adaptive Management

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties. All projects face uncertainties with the principal sources of uncertainty including (1) incomplete description and understanding of relevant ecosystem structure and function,

(2) imprecise relationships between project management actions and corresponding outcomes, (3) engineering challenges in implementing project alternatives, and (4) ambiguous management and decision-making processes.

Given these uncertainties, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. In the case of the Manteo 204 project, an adaptive management program would use the results of continued project monitoring to manage the project in order to achieve the previously stated project goals and objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

Based on the current draft Adaptive Management Technical Guide (2012) by the USACE National Adaptive Management Team, an evaluation (below) was performed to help determine if adaptive management should/could be applied to the project.

1) Is the ecosystems to be restored sufficiently understood in terms of hydrology and ecology, and can project outcomes be accurately predicted given recognized natural and anthropogenic stressors?
Yes- as demonstrated by a nearby successful reference at Crab Hole sanctuary.

2) Can the most effective project design and operation to achieve project goals and objectives be readily identified?
Yes- High relief structures would be consistent with NCDMF current practice.

3) Are the measures of this restoration project's performance well understood and agreed upon by all parties?
Yes- Performance measures will be consistent with established NCDMF Sanctuary Program monitoring measures.

4) Can project management actions be adjusted in relation to monitoring results (is there flexibility)?
Yes- poor oyster recruitment resulting from possible sedimentation could be improved by addition of clean cultch.

Typically, a 'No' answer to questions 1 through 3 and a 'Yes' answer to question 4 identifies the project as a candidate that could benefit from adaptive management. However, for the Manteo 204 project, the answers to questions 1-3 are 'Yes' therefore it was determined that the Manteo 204 project is not a good candidate for adaptive management even though the answer to question 4 was also 'Yes' and therefore no adaptive management is proposed. Although there is some flexibility in the project design and activities could be conducted to adjust project performance, these actions would not be considered adaptive management activities. Actions such as, reseeding the oysters by adding additional clutch, would be considered maintenance activities and would be conducted during and funded through OMRR&R activities.

6.4 Operation, Maintenance and Replacement Considerations

Under the Section 204 authority, it is the responsibility of the local sponsor to maintain the project after construction. It is anticipated that minimal O&M activity will be required to maintain the functionality of the reef after construction. This would include replacing cultch with clean attachment substrate, if required as a result of poor recruitment. Replacement of oyster cultch would included include the replacement of 25 percent of the original cultch at a cost of $26,000.

Additionally, marker buoys would require replacement every two years. If 3-legged piles are used only one replacement would be expected during the project life. Cost to mark the corners of the sanctuary site with a three-legged piling system according to U.S. Coast Guard regulations and state permit is estimated to be $1,500 per pilling x 12 pilings = $18,000. Assuming these are replaced at year 25, maintenance costs would be $18,000 over the life of the project.

6.5 Detailed Cost Estimate for Tentatively-Selected Plan

Total Project Cost (Fully Funded) including contingency is $7,217,000. For more detail and Cost MCX Certification, see Appendix D – Cost Engineering.

Table 6.02 *Total Project Costs*

TENTATIVELY-SELECTED PLAN, ALTERNATIVE 16
"THREE 5.07 ACRE SITES
WITH 4-FOOT STONE SILL CONTAINMENT STRUCTURE"
MANTEO, OLD HOUSE CHANNEL, NC
SECTION 204 PROJECT

TOTAL PROJECT COSTS (Includes 19% Contingency)

Estimate Date: 2 August 2012

	Prices
TOTAL PROJECT COSTS (FULLY FUNDED)	$7,217,000
Non-Federal Share	
Real Estate **	$38,125
Cash Contribution (35% of total implementation costs less RE)	$2,328,875
TOTAL	$2,367,000
Federal Share	
Total Cost less Non-Federal Share	$4,396,000
Feasibility Phase Cost, 100% Federally funded	$453,000
TOTAL*	$4,850,000

* The TOTAL maximum Federal expenditures on any one project under this authority is a maximum of $5,000,000. Any costs over the $5,000,000 Federal limit will be 100% non-Federal and reflected as such in the PPA.

** Real Estate costs in this table do not include related Federally incurred costs.

6.6 Cost Sharing

Under the Section 204 authority, the non-Federal sponsor is responsible for 35% of the Total Project Costs minus the feasibility phase costs.

7.0 SUMMARY OF ENVIRONMENTAL IMPACTS

This section compares the impacts of the proposed Preferred Alternative (three 5.07 acre sites with 4-foot stone sill containment) and the No-Action alternative. Fifteen alternatives that were eliminated from further consideration are outlined in section 5.3.3.

7.1 General Environmental Conditions

Neither the Preferred Alternative nor the No Action Alternative is expected to impact any environmental conditions within the study area or greater Pamlico Sound. Impact analyses of the environmental conditions are outlined below and summarized in table 7.01.

7.1.1 Climate

Climate in the Pamlico Sound depends significantly on the Gulf Stream and the Labrador currents. As the Preferred or the No Action Alternatives would not have any impacts on these currents, neither the Preferred nor the No Action alternative would have an impact on the climate.

7.1.2 Tides, Currents, and Sea Level Rise

It is not expected that either the Preferred or No Action Alternative would significantly impact tides, currents, or sea level rise in the Pamlico Sound. Slight alteration of currents around the Preferred Alternative would result in minor localized changes in currents but should not have any impact on currents in the greater Pamlico Sound, nor would any potential localized changes be significant enough to alter the local conditions. Potential increase in sea level rise (between 0.87 and 2.2 feet over 50 years) would not impact the function of the alternatives discussed in the report. The elevation design of the preferred alternative is set to provide a minimum depth for safe vessel navigation and any rise in water level just provides additional buffer between the vessel and the reef/bottom.

7.1.3 Water Quality

The placement of armor stone and dredged material for this project, from the Federally authorized Navigation channel, would result in minor temporary turbidity during the construction but overall impacts to water quality would be minimal and of short duration. The Preferred Alternative would not contribute to point or non-point sources of pollutants and would not have any long-term negative impacts to water quality in the Pamlico Sound. Establishment of oysters on these constructed reefs would have positive benefits to water quality. A 401 Water Quality Certification would be required prior to construction.

Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) evaluation in appendix L.

The No Action Alternative would have no adverse impacts on water quality.

7.1.4 Current Land Use in Project Area

Neither the Preferred Alternative nor the No Action Alternative would impact land use, as the project is located entirely within the waters of Pamlico Sound, away from all major upland areas.

7.2 BIOTIC COMMUNITIES

The Preferred Alternative is not expected to have any long term negative impacts on biotic communities within the project area or the Pamlico Sound. The vast majority of impacts to biotic communities would be in the placement of the rock sill with minor impacts as the area is recolonized by new species. Placement of the rock substrate would result in a permanent change in habitat substrate. Positive impacts associated with construction of the structures and stone sill substrate in an otherwise sandy flat community would provide benefits to species that would utilize the hard surfaces and higher surface elevation.

The No Action alternative would not have any impacts to biotic communities or facilitate the growth of certain communities that would utilize the structure and vertical elevation that would be provided by the Preferred Alternative. These impacts to biotic communities are outlined below.

7.2.1 Aquatic Habitats

7.2.1.1 Submerged Aquatic Vegetation

The Preferred Alternative would not be located on or in the vicinity of any SAV beds as the nearest SAV bed is one-mile west of the proposed project site and would be far enough away from identified beds in the surveyed project area that potential negative impacts (turbidity) would be significantly reduced or eliminated (Figure 5.01). Construction would utilize methods to keep turbidity contained in the construction zone, further reducing or eliminating any impacts that would be associated with sedimentation on the SAV habitat.

The No Action Alternative would have no impacts on SAV.

7.2.1.2 Shell Bottoms.

The Preferred Alternative would be sited to keep the proposed oyster reef location away from the known low relief shell bottom habitat identified in the survey area approximately 0.5 miles north of the proposed site and oyster sanctuaries in the relatively near vicinity (Figure 5.01). By avoiding known shell bottoms and locating the proposed project area far enough away to avoid sedimentation from the construction of the stone sill, and associated placement of dredged material, the Preferred Alternative

would not impact shell bottom. Positive impacts of providing habitat suitable for establishment of oysters and utilization by other species would provide positive benefits to an area that is dominated by soft bottom habitat.

The No Action Alternative would not provide additional oyster habitat and would not impact any shell bottom within the study area.

7.2.1.3 Soft Bottom

Soft bottom makes up the majority of the substrate that will be altered under the Preferred Alternative. Construction would require the addition of rock sills which add hardened substrate to an otherwise sandy soft habitat with the total project area converting 5.07 acres of the sandy bottom to a higher relief hardbottom. However, these impacts and impacts associated with placing material would be expected to be minimal and, overall, provide more habitat diversity to the aquatic habitat. Dredged materials placed in the project area are expected to be of similar type and quality to that of the project area sediments. Invertebrates that utilize soft substrates would be expected to quickly re-colonize the sediments in the area.

The No Action Alternative would not impact the soft bottoms or the associated communities in the project area.

7.2.2 Bird Islands

Construction of the Preferred Alternative should not adversely impact the nearby bird islands. As many of the effluent islands have exceeded capacity for good bird habitat by leaving them susceptible to predatory hazards, reducing the amount of material placed on these islands will promote a healthier and safer habitat for the birds that utilize the islands. Reduction in future material placement would therefore provide an overall positive impact to coastal bird communities.

The No Action Alternative would not directly impact bird islands or coastal birds. Secondary negative effects may occur by not providing an alternative disposal location for material that would otherwise go on islands that are already at or over capacity and subject to increases in predation.

7.2.3 Wetlands

While the Pamlico Sound contains estuarine wetlands, the proposed project area is not located in the vicinity of any wetlands. Therefore, there would be no impacts to wetlands from construction of the Preferred Alternative nor would there be impacts associated with the No Action Alternative.

As stated in section 7.1.3, Pursuant to Section 404 of the Clean Water Act, the impacts associated with the discharge of fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) evaluation in appendix L. While the

U.S. Army Corps of Engineers does not issue permits to its own agency, the agency complies with 404 regulations and nationwide permit conditions.

7.3 Threatened and Endangered Species

Neither the Preferred Alternative nor the No Action Alternative would be expected to have any adverse impacts to Threatened or Endangered Species that may be encountered in the project area. Potential species and associated assessment of impacts are outlined below.

Manatee. Pamlico Sound has not historically had manatee populations of any significant size, and manatees are not expected to be encountered in the project area. However, transport of materials as well as activities at the construction site would follow all manatee protocols regarding vessel traffic, further reducing any potential impacts associated with transport or construction. Therefore, the Preferred Alternative may affect but is not likely to adversely affect the species.

The No Action Alternative would not adversely impact the manatee.

Shortnose Sturgeon. The Preferred Alternative would not be located in habitat or breeding areas regularly utilized by shortnose sturgeon. Any sturgeon in the immediate project vicinity would be expected to safely transition out of the area with no impacts to individuals or the population. The project is in the vicinity of Oregon Inlet which is used by shortnose sturgeon as access to the estuary from the ocean. Structures related to the preferred alternative would not hinder access. Therefore, the Preferred Alternative may affect but is not likely to adversely affect shortnose sturgeon.

The No Action Alternative would not be expected to adversely affect shortnose sturgeon.

Atlantic sturgeon. The Preferred Alternative would not be located in habitat or breeding areas regularly utilized by Atlantic sturgeon. Any sturgeon in the immediate project vicinity would be expected to safely transition out of the area with no impacts to individuals or the population. The project is in the vicinity of Oregon Inlet which is used by shortnose sturgeon as access to the estuary from the ocean. Structures related to the preferred alternative would not hinder access. Therefore, the Preferred Alternative may affect but is not likely to adversely affect Atlantic sturgeon.

The No Action Alternative would not be expected to adversely affect Atlantic sturgeon.

Sea turtles. While sea turtles may potentially appear in the area, it is not anticipated that these species would be adversely affected by the Preferred Alternative. Planning for construction of the Preferred Alternative would include scheduling construction at times of the year when chances of encounters with sea turtles would be reduced to minimize potential impacts. While there are currently no restrictions on dredging, any schedule constraints would be based on the Operations and Maintenance contracts and, if any, windows for disposal established during consistency coordination. During

construction, it is anticipated that a hydraulic pipeline dredge would be used although the dredge project has authority to use other dredges. The Preferred Alternative would not impact beaches adjacent to the proposed project area, where sea turtles have been known to nest.

The No Action Alternative would not result in adverse affects to sea turtles.

Birds. As the Preferred Alternative would not be located within the immediate vicinity of islands or beaches where Piping Plovers or Roseate Terns nest, and would not impact fisheries resources that shorebirds rely on, no negative effects are anticipated beyond the potential temporary minor impacts associated with disturbance by equipment during the construction phase. Therefore, this project may affect but is not likely to adversely affect threatened or endangered bird species.

The No Action Alternative would not have any adverse effects to Threatened or Endangered bird species.

7.4 Benthic Resources

The Preferred Alternative is not expected to negatively impact benthic resources beyond minor temporary impacts during placement of dredged material during construction. Minor impacts would be associated with burial of species located on the sandy bottom habitat. However, due to the nature of the system being highly dynamic, these impacts are not expected to be long term with species recovering in the immediate area rapidly following the disturbance. Facilitation of oyster growth by providing suitable habitat should promote not only oysters but other benthic organisms that would utilize the constructed reef.

The No Action Alternative is not expected to negatively impact benthic resources; however, by not providing additional habitat that can be utilized by benthic species, the No Action Alternative would not promote growth of the benthic community. Therefore, with the No Action Alternative, conditions would be expected to remain generally status quo with minimal to no impacts to resources.

7.5 Essential Fish Habitat (EFH) and Fisheries

Potential impacts to EFH and HAPC that are in the project area of the Preferred Plan are discussed and summarized in the following paragraphs.

Aquatic Beds. Aquatic beds (defined as assemblages of submerged rooted vascular vegetation found in tidal freshwater areas) are not found in the immediate project area due to the salinity of waters; therefore, no impacts from the Preferred or No Action Alternatives would occur.

Estuarine Water Column. The Preferred Alternative is expected to create localized, short-lived turbidity elevations that should dissipate within the estuarine water column in

a short time period. In addition to the actions of winds, waves, and currents, the duration of these turbidities would be dependent upon the grain-size of material being placed: the finer the grain-size, the slower the return to pre-construction conditions. The results of grain-size analyses from Old House Channel and past dredging events show that sand is the predominant sediment and, as such it is expected that turbidities would be slightly elevated above those routinely present in the area but should return to normal levels quickly once construction is complete, with minimal and short-term impacts.

The No Action Alternative would not result in any impacts to the estuarine water column.

Oyster Reefs and Shell Banks. These habitat types are present in the area of Pamlico Sound and occur within the project study area (see figure 4.04). Placement of dredged material under the Preferred Alternative is not expected to affect these habitats, as the Preferred Alternative would be located in areas away from oyster reefs and shell banks. Turbidities as a result of construction would be far enough removed from any potential reefs or shell banks as to not cause impacts to those resources. Construction of additional oyster reefs should have positive impacts to the surrounding populations by providing additional habitat that is currently unavailable to oysters due to the depth and lack of suitable substrate. The preferred alternative is not expected to cause any negative impacts to oyster reefs and should result in overall positive impacts to the oyster community in Pamlico Sound.

The no action alternative should not provide any direct negative impacts but will not provide additional oyster and shell habitat thereby not supporting North Carolina's oyster restoration goals.

SAV and Seagrasses. Shallow bottom within the project study area (Figure 4.04) contains habitat suitable for SAV and SAV communities. The proposed oyster reef construction could potentially impact SAV habitat. However, precautions would be taken to avoid areas where SAV are known to exist and the Preferred Alternative location will be far enough away from SAV to eliminate potential impacts from burial or turbidity during construction with the nearest site being located currently one-mile north of the proposed site. Once constructed, the Preferred Alternative should have no negative impacts and may possibly, as a secondary benefit, facilitate SAV growth in nearby waters if water clarity improves due to filtering by oysters.

The No Action Alternative would have no impact on any known SAV or its habitat.

State–designated Areas Important for Managed Species. Primary Nursery Areas (PNAs) are designated by the NC Marine Fisheries Commission and are defined as tidal saltwaters that provide essential habitat for the early development of commercially important fish and shellfish. There are PNAs in Pamlico Sound, but this project is at least five-miles away from these locations so that neither the construction of the oyster reefs nor the disposal would have adverse impacts.

The No Action Alternative would have no impacts on any State-designated areas.

Impact Summary for Essential Fish Habitat. Adverse impacts to EFH, HAPC, or EFH species from construction of the Preferred Alternative, if any, has been determined to be minimal and short-lived on an individual and cumulative effects basis. As a result of these minimal impacts and based on agency coordination at the January 10, 2012 meeting in Manteo, NC, mitigation to offset impacts is not expected to be required. This assessment will be coordinated with the NMFS Southeast Region.

7.6 Sediments

Due to the highly dynamic environment of Oregon Inlet and Pamlico Sound, it is not expected that the relocation of sediments from the Federally Authorized channel to the Preferred Alternative location would have any significant long term impacts to sediments in the project area. Sediment composition is consistent between the channel and preferred alternative location, so grain size and quality is not expected to change during construction of the Preferred Alternative. Project impacts during construction may include slightly elevated turbidity conditions at the Preferred Alternative site however; this is expected to be a short-term impact with sediments settling rapidly in the system.

The No Action alternative will not impact sediments in Pamlico Sound.

7.7 Coastal Processes

The proposed project would be located beneath the water surface at all times, leaving the site relatively protected from the effects of winds, waves, and tidal fluxes. Due to the submerged location it is not expected that the project would alter the coastal processes of the project area; therefore, no impacts to coastal processes are expected.

The No Action alternative would not impact coastal processes.

7.8 Air Quality

The Preferred Alternative would result in minimal temporary impacts to air quality during the construction phase of the project. Air emissions would be slightly elevated during construction from the operation of heavy machinery and vessel equipment. These impacts are expected to be minimal and short term. No open burning would occur during any phase of this project.

The No Action Alternative will not result in increases in air emissions and will have no impact on air quality.

7.9 Socio-Economics and Recreation

The Preferred Alternative would provide additional fishing and shellfish habitat boosting both local recreational fisheries and the tourism industry in the areas surrounding the

project site. This would have a positive effect on the local community. Design of the Preferred Alternative avoids any impacts to navigation and, by providing an additional disposal location for material dredged from the channel to maintain navigation depth, aids in maintaining the federally authorized navigation channels which support the local economy.

The No Action Alternative is not expected to have any impacts on the local economy or recreation.

7.10 Cultural Resources

After review of the ERDC survey report conducted by the USACE Field Research Facility in Duck, NC, the North Carolina State Historic Preservation Office concluded that it was unlikely that the Manteo 204 project would affect any significant submerged resources (Appendix H).

7.11 Hazardous, Toxic, and Radioactive Wastes

The Preferred Alternative will not be located in any area where HTRW have been identified nor will the alternative result in the creation of HTRW. No impacts related to HTRW are expected to occur with either the Preferred or No Action Alternatives.

7.12 Floodplains

As the project is not located within a floodplain and will not alter any surrounding floodplains, neither the Preferred Alternative nor the No Action Alternative will cause any impacts to floodplains.

7.13 Cumulative Impacts

Cumulative impacts associated with the preferred alternative were considered. There are ten existing state estuarine reefs in the greater Pamlico Sound; of these, two are within 2.5 miles of the proposed site. These reefs were constructed at or over a decade ago by NCDMF and cover a total of 39 acres. Another reef within the vicinity is currently in the planning stage with no additional new reefs expected in the foreseeable future within Pamlico Sound, other than the proposed project. The success of the sanctuaries in the Albemarle-Pamlico Estuary System along with the success of the naturally sustaining subtidal oyster reef ecosystem restoration project at Festival Park suggest that the preferred plan will facilitate further re-establishment of oysters in the Pamlico Sound and aid in creating a more stable naturally sustainable oyster population.

Additional projects in the area include the Manteo (shallowbag) Bay project which was authorized in 1940 and is considered a navigation maintenance project. This project includes maintenance of several navigation channels and runs parallel to the Outer Banks adjacent to the proposed project site. No other federal dredge work is proposed for this project area. Proposed project design using material from this maintenance

channel would provide an alternative location for placement of channel materials relieving the adjacent islands of the excess dredged material which will benefit both the birds that may utilize the islands while providing available substrate for oyster recruitment.

As a proposed beneficial use of dredged material project, net effects are expected to be beneficial. Any adverse effects would be minor and temporary, associated with construction disturbance. An insignificant reduction in soft bottom habitat would occur as soft bottoms are converted to oyster habitat.

Table 7.01 Summary of Environmental Impacts

Resource	Alternatives	
	Proposed Action **3-5.07 Acre sites with 4-foot stone sill containment**	**No Action**
Climate	No impacts	No impacts
Tides, Currents, and Sea Level Rise	No impacts	No impacts
Water Quality	Minor temporary turbidity during construction Long term positive benefits from Oysters	No impacts
Land Use	No impacts	No impacts
SAV	Potential minor short-term turbidity	No impacts
Shell Bottom	No impacts to existing hardbottom Positive benefits from increased available habitat	No impacts to existing hardbottom No additional habitat
Soft Bottom	Loss of soft bottom habitat at constructed reef	No impacts
Bird Islands	Reduced predation and disposal placement on islands	Potential increase in predation and continued frequent disposal on islands
Wetlands	No impacts	No impacts
Threatened and Endangered Species	No impacts expected	No impacts

Resource	Alternatives	
	Proposed Action **3-5.07 Acre sites with 4-foot stone sill containment**	**No Action**
Benthic Resources	Facilitation of habitat to promote benthic growth	No impacts
EFH	Minimal to no impacts	No impacts No additional shell habitat
Sediments	Short-term elevated turbidity	No impacts
Coastal Processes	No impacts	No impacts
Air Quality	Short term elevated emissions	No impacts
Socio-economics	Boost local recreational fisheries	No impacts
Cultural Resources	No impacts expected	No impacts
HTRW	No impacts	No impacts
Floodplains	No impacts	No impacts

8.0 COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND EXECUTIVE ORDERS

The Recommended Plan, as built, must comply with applicable state and federal environmental protection statutes and executive orders, including NEPA. Applicable state and federal permitting, with the required public review, must be accomplished prior to construction of the project. A listing of the federal laws and policies and their compliance status is located in Table 8.01.

Table 8.01. Listing of Public Laws and Compliance Status (Note: Items identified as being in *Full Compliance* assumes their compliance status after the NEPA process is complete.)

Title of public law	U.S. Code	Compliance status
Abandoned Shipwreck Act of 1987	43 U.S.C. 2101	Full Compliance
American Indian Religious Freedom Act	42 U.S.C. 1996	Not Applicable
Agriculture and Food Act (Farmland Protection Policy Act) of 1981	7 U.S.C. 4201 et seq.	Not Applicable
American Folklife Preservation Act of 1976, As Amended	20 U.S.C. 2101	Not Applicable
Anadromous Fish Conservation Act of 1965, As Amended	16 U.S.C. 757 a et seq.	Full Compliance
Antiquities Act of 1906, As Amended	16 U.S.C. 431	Full Compliance
Archeological and Historic Preservation Act of 1974, As Amended	16 U.S.C. 469	Full Compliance
Archeological Resources Protection Act of 1979, As Amended	16 U.S.C. 470	Full Compliance
Bald Eagle Act of 1972	16 U.S.C. 668	Full Compliance
Buy American Act	41 U.S.C. 102	Full Compliance
Civil Rights Act of 1964 (P.L. 88-352)	6 U.S.C. 601	Full Compliance
Clean Air Act of 1972, As Amended	42 U.S.C. 7401 et seq.	Full Compliance
Clean Water Act of 1972, As Amended	33 U.S.C. 1251 et seq.	Full Compliance
Coastal Barrier Resources Act of 1982	16 U.S.C. 3501-3510	Full Compliance
Coastal Zone Management Act of 1972, As Amended	16 U.S.C. 1451 et seq.	Full Compliance
Comprehensive Environmental Response, Compensation and Liability Act of 1980	42 U.S.C. 9601	Not Applicable
Conservation of Forest Lands Act of 1960	16 U.S.C. 580 mn	Not Applicable
Contract Work Hours	40 U.S.C. 327	Full Compliance
Convict Labor	18 U.S.C. 4082	Full Compliance
Copeland Anti-Kickback	40 U.S.C. 276c	Full Compliance
Davis Bacon Act	40 U.S.C. 276	Full Compliance
Deepwater Port Act of 1974, As Amended	33 U.S.C. 1501	Not Applicable
Emergency Flood Control Funds Act of 1955, As Amended	33 U.S.C. 701m	Not Applicable
Emergency Wetlands Resources Act	16 U.S.C. 3901-3932	Full Compliance
Endangered Species Act of 1973	16 U.S.C. 1531	Full Compliance
Estuary Program Act of 1968	16 U.S.C. 1221 et seq.	Full Compliance
Equal Opportunity	42 U.S.C. 2000d	Full Compliance
Farmland Protection Policy Act	7 U.S.C. 4201 et seq.	Not Applicable

Federal Environmental Pesticide Act of 1972	7 U.S.C. 136 et seq.	Full Compliance
Federal Water Project Recreation Act of 1965, As Amended	16 U.S.C. 4601	Full Compliance
Title of public law	U.S. Code	Compliance status
Fish and Wildlife Coordination Act of 1958, As Amended	16 U.S.C. 661	Full Compliance
Flood Control Act of 1944, As Amended, Section 4	16 U.S.C. 460b	Full Compliance
Food Security Act of 1985 (Swampbuster)	16 U.S.C. 3811 et seq.	Not Applicable
Hazardous Substance Response Revenue Act of 1980, As Amended	26 U.S.C. 4611	Not Applicable

9.0 SUMMARY COORDINATION, PUBLIC VIEWS, AND COMMENTS

9.1 Scoping Comments and NEPA Coordination

A scoping letter describing the proposed project, dated May 27, 2009, was circulated to resource agencies and the public for review and comment. There were no comments received from the general public. All scoping comments from other agencies were considered during the development of this project. A summary of comments received from stakeholder organizations and resource agencies, along with USACE responses referenced to appropriate sections of this document, is presented in Appendix A. Copies of NEPA coordination letters from review of the draft report are located in Appendix K.

9.2 Stakeholder Meetings

In addition to ongoing communication via phone and e-mail, an agency coordination meeting was held in Manteo, NC on January 10, 2012 with representatives from the following agencies and stakeholders: National Marine Fisheries, NC Division of Marine Fisheries, NC Division of Water Resources, NC Shellfish Sanitation, NC Ferry Division, NCDCM, and The Nature Conservancy.

10.0 PLAN IMPLEMENTATION

10.1 Non-Federal Responsibilities

The State of North Carolina, as stated in a letter dated July 15, 2008 (Appendix B), has expressed support of the project with the financial capability to execute a project partnership agreement, and has agreed to accept the role of non-Federal sponsor in event of approval of a final detailed project report. The State of North Carolina has statutory authority under the Federal Water Resources Development Law of 1969 (G.S. 143-215.38 et. seq.) to make binding commitments to carry out the non-Federal

responsibilities related to USACE projects, including making cash contributions to projects. In order to implement the Selected Alternative, the State of North Carolina, as non-Federal sponsor, would be responsible for the following:

1. Legal provision, without cost to the U.S. Government, of all necessary land, easements, rights-of-way, and access routes necessary for project construction and subsequent operation and maintenance. Land provisions would include:

    a. construction site to accommodate all oyster restoration habitat improvement features to be constructed, and

    b. Temporary staging area(s) of acceptable location and acreage for contractor's use during construction period.

2. Cash contribution, provided during the period of implementation, toward cost of the project totaling 35% of project first cost, less value of the non-Federal sponsor's real estate contribution. The amount of cash contribution is currently estimated to be $2,328,875. The State of North Carolina has stated their intent by letter dated July 15, 2008 (Appendix B), to accept the non-Federal sponsor's responsibilities as defined in a Project Partnership Agreement, should a final detailed project report be approved.

3. Funding of 100% of the cost of Annual Operation and Maintenance (O&M) required to keep the project in viable condition to satisfy its design function. This funding would not be provided for initial implementation of the project, but would become a yearly responsibility of the non-Federal sponsor upon completion of the construction phase. O&M costs are estimated to be $18,000 over the life of the project (see section 6.3 for details).

4. Satisfy all provisions of the Project Partnership Agreement (PPA) regarding non-Federal sponsor responsibilities in implementing the project.

10.2 Federal Responsibilities

In order to implement the Selected Alternative, the USACE would provide the Federal share of project cost, to equal project first cost less the total non-Federal share, not including Annual Operation and Maintenance expenses. The Federal share of project cost is currently estimated to be $4,396,000, not including feasibility phase costs. Total Federal expenditures on any one project under Section 204 authority may not exceed a total of $5 million. The additional cost of Federal Feasibility Phase work, currently estimated at $453,000 would be 100% Federally-funded. The USACE would also provide the following:

1. Review and certification of Real Estate provisions.
2. Planning, Engineering, and Design (PED) of the project.
3. Contracting for project construction.
4. Supervision and Administration of project construction.

10.3 Work-in-Kind

Work-in-Kind is defined as work contributed by the non-Federal sponsor toward implementation of a project, in lieu of payment of a portion of the sponsor's cash contributions toward implementation of the project. In some cases, completed Work-in-Kind may be credited by the USACE to the non-Federal sponsor, resulting in a reduction of their cash contribution on behalf of the project. The NCDMF has expert knowledge of oyster management in the project area with facilities and capability to provide and or place cultch and conduct oyster monitoring. Coordination is underway with the sponsor to determine their interest in providing work in-kind.

10.4 Project Partnership Agreement (PPA)

Upon approval of a final detailed project report for this Manteo, Old House Channel, NC Section 204 project, a project partnership agreement (PPA) would be created. A PPA is a legally binding agreement between the Federal government (in this case, the USACE) and a non-Federal sponsor (in this case, the State of North Carolina) for construction of a water resources project, in this case, the Manteo, Old House Channel, NC - Beneficial Use of Dredged Material for Oyster Reef Restoration Project. The PPA would describe the project and the responsibilities of the USACE and the State of North Carolina in the cost sharing and execution of project work.

10.5 Sponsor Views

The State of North Carolina, as non-Federal sponsor, has expressed support for this project by requesting the USACE, in 2008, to investigate opportunities for oyster restoration in the Pamlico system (See letter from the North Carolina Department of Natural Resources, Division of Water Resources, dated July 15, 2008, in Appendix B). The State also enacted new coastal stormwater rules at that time to protect and improve the water quality in the Pamlico system, which, along with its oyster populations, had experienced indicators signaling the potential of continuing decline. The State has also indicated a willingness and financial capability to execute a project partnership agreement (PPA) should this detailed project report be approved. The State's preference among the alternative plans ("Locally-Preferred Alternative") is Alternative 16 (3 5-acre reef complex with stone containment). Since this alternative is also the Federally-Recommended Alternative, it is considered the Recommended Plan.

11.0 RECOMMENDATIONS

The Tentatively-Selected Plan, Alternative 16, has been determined to be the plan that would provide the greatest ecosystem restoration benefits in the most cost effective manner within the cost constraints of the Section 204 Authority, and is also the plan most desirable to the local sponsor while having minimal adverse environmental

impacts. This plan has therefore been selected as the Recommended Plan for implementation, upon approval of a final detailed project report and execution of a PPA.

12.0 DRAFT FINDING OF NO SIGNIFICANT IMPACT

The proposed action is not expected to significantly affect the quality of the human environment. If this determination is confirmed through coordination of this EA, an Environmental Impact Statement will not be required, and a Finding of No Significant Impact (FONSI) will be signed prior to the initiation of the proposed action. The signed FONSI will be made available to the public.

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